FOR INFORMATIONAL USE ONLY - NOT TO BE USED FOR BIDDING PURPOSES

PROPOSAL

TO BE COMPLETED BY CONTRACTORS SUBMITTING A BID ON S35121-06G						
ITEM NO.	APPROX. QUANTITIES	ITEMS BID WITH AMOUNT BID WRITTEN IN WORDS				
1.	Lump Sum	Base Bid for furnishing all Labor, Materials and Equipment required for all Construction work ready for operation, inclusive of work covered under South Shore WRF Aeration Blower Facility.	N/A	N/A		
2	Allowance	Contingency for furnishing all labor, materials, equipment, and incidentals for unforeseen conditions and associated additional work. TWO MILLION DOLLARS ZERO CENTS	$2,000,000	00		

FOR INFORMATIONAL USE ONLY - NOT TO BE USED FOR BIDDING PURPOSES

ALLOWANCES

It is expressly understood and agreed that the total Bid presented in this Proposal is the basis for establishing the amount of the Bid Security and includes the following allowances:

- Item No. 2: An allowance of two million thousand dollars ($2,000,000.00) for unforeseen conditions, as specified in Section 01020 – Allowances.

All in accordance with the requirements of Division 1, Special Conditions; Section 01010, Summary of Work; Section 01020, Allowances; and Section 01500, Temporary Facilities and Controls.

Final Contract Payment for allowance items shall be based upon actual payments, and not on the approximate amounts cited herein.

DETERMINATION OF LOW BID

Determination of low Bid will be made by comparing the Total Base Bid which shall include the lump sum Base Bid price, unit price totals and allowances, plus the Add Alternate(s), taken in order, or none of them, whichever amount(s) shall be judged by the Commissioner of Public Works to be in the best interest of the County.

MAJOR EQUIPMENT ITEMS

The Bidder shall fill the name and address of the one proposed manufacturer for each major equipment item tabulated hereinafter. It is expressly understood that the furnishing of this information will not relieve the Bidder of any requirements of the Contract Documents and failure to fill out properly is grounds for rejection.

Specification Number	Description	Manufacturer/Vendor
11310	Direct Drive Single Stage Centrifugal Blowers	
13401	I&C Supplier	
15064	Fabricated Stainless Steel Pipe	
15100	High Performance Butterfly Valves	
15100	Double Disk Check Valves	
15100	Resilient-Seated Gate Valves	
15100	Resilient-Seated Knife Gate Valves	
15100	Eccentric Plug Valves	
15100	Pressure Relief Valves	
15100	Electric Valve Actuators	
15120	Expansion Couplings	
16293	Metal-Clad Switchgear	
16294	Medium Voltage Solid State Starters	
16482	Motor Control Centers	

SOUTH SHORE WRF
Aeration Blower Facility

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Overall SWPPP

+ + END OF SECTION + +

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SECTION 01010

SUMMARY OF WORK

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. The Work to be done under this Contract and in accordance with these Specifications consists of furnishing of equipment, superintendence, labor, skill, material, and all other items necessary for the South Shore WRF Aeration Blower Facility Contract No. S35121-06G located in East Rockaway, Nassau County, New York.

B. The broad scope of this project is to construct a new Aeration Blower Building located on the South Shore WRF campus along the northern wall of the existing process aeration tanks, and realignment of an existing paved access road and below ground utilities that conflict with the location of the new Aeration Blower Building. The new Aeration Blower Building will be constructed with a finished floor elevation located above the design flood elevation and include the installation of five (5) new direct drive single-stage integrally geared centrifugal (IGC) blowers, dissolved oxygen sensors, and associated PLC-based controls designed to deliver enough air across the range of operating conditions to support biological nutrient removal (BNR). A new overhead aeration header will also be constructed and connected to new process aeration piping located in the aeration tank wye walls, and new drop leg connections made to aeration diffusers.

C. The principal features of the Work to be performed and equipment to be provided for this Project under this Contract includes:
   1. All labor, equipment, fees, permits, and other related costs necessary for
      a. Site clearing and surface feature demolition in the area to be impacted by the construction of a new Aeration Blower Building.
      b. Below ground new and relocated utility installtions.
      c. Installation of pile foundation and shear walls/grade beams.
      d. Construction of new Aeration Blower Building structure.
      e. Furnish and install new process aeration blower equipment including all supporting electrical power and control panels and associated wiring.
      f. Furnish and install new Aeration Blower Building mechanical, electrical and plumbing systems.
      g. Furnish and install new overhead aeration header piping including structure supports.
      h. Removal and disposal of existing aeration piping located within the wye walls of the existing aeration tanks.
      i. Furnish and install new aeration piping and drop leg connections to the existing aeration tank diffusers.
      j. Furnish and install new dissolved oxygen sensors and associated power and control wiring.
      k. Site restoration.

2. The foregoing stated in Paragraph 1.01B and 1.01C is a general description only and shall not be construed as a complete description of the Work to be performed for this Project.
3. Contractor parking shall be as designated by County and Veolia or in approved Contractor staging areas as noted on the contract documents.

D. Delays due to lack of available labor, supervision, equipment, etc. will not be acceptable.

E. The existing plant will be maintained in continuous operation by the County during the entire construction period. Work under this Contract shall be so scheduled and conducted by the Contractor that such Work will not impede any treatment process, reduce the quality of the plant effluent or cause odor or other nuisance. In performing the Work shown and specified, the Contractor shall plan and schedule his Work to meet the plant and collection system operating requirements.

F. The construction sequence, as described in Section 01700, Maintenance of Plant Operations, must be maintained so that the County will meet the New York State Pollutant Discharge Elimination System Permit requirements for the Plant.

G. Additional details concerning storm water permit compliance and pollution prevention plans can be found in the Federal Regulations 40 CFR 122 & 123.

1.2 GENERAL

A. The Instructions to Bidders, Agreement, General Conditions, and Division 1, General Requirements, specifications shall apply to all Work under the Contract for this Project.

B. Where articles of the Instructions to Bidders, Agreement, and General Conditions are repeated in the Sections of Division 1, General Requirements, it is intended to elaborate or qualify such articles. It is not intended that other articles of the above documents shall be omitted or that additional requirements set forth in the above documents and noted herein shall be excluded from Contract requirements unless specifically noted as such hereinafter.

C. Where the words "Contract" and "Contractor" are used in Sections of Division 1, General Requirements, they shall apply equally to all parties entering into agreements with the County to perform Work specified herein and to all Contracts derived from said agreements.

1.3 CONTRACT DOCUMENTS

A. The Contract Documents consist of the Notice and Instructions to Bidders, Bid Bond, Proposal, Agreement, General Conditions, the Technical Specifications, and the Contract Drawings.

1.4 GENERAL ARRANGEMENT

A. The Contract Drawings indicate the extent and general arrangement of the Work. The specific equipment proposed for use by the Contractor on the Project may require

changes in the construction detailed on the Contract Drawings, and all such changes shall be performed in accordance with the requirements of the General Conditions, Article GC 17, "Materials and Equipment, Approvals, Substitutions and Deviations", and shall be made without additional cost to the County and shall include the increase in costs of the other Contracts.

B. In the preparation of the revised plans, clearance, access, walkway widths, stairways, headroom and other building and equipment layout features shall be equal to those shown on the original Plans. All materials involved in the redesign shall conform to the applicable provisions of the Technical Specifications.

1.5 TIME OF WORK

A. Overtime work by the Contractor necessary to conform to the requirements of Division 1, General Requirements, Section 01700, Maintenance of Plant Operations, shall be considered as normal procedure under this Contract, and the Contractor shall make no claims for extra compensation as a result thereof. The Contractor shall be prepared to work around the clock and supply multiple work crews as necessary to complete the Work including testing and acceptance as specified, within the specified time frame and the time of completion set forth in the Contract Documents.

B. The normal working hours for the project are between 7:00 AM and 3:30 PM Monday through Friday. When required to meet the Contract Completion dates, the Contractor is advised that they shall work scheduled overtime or second shifts as needed. The Contractors shall have sufficient construction materials, labor, equipment, tools and supervision to support scheduled overtime or second shifts when required.

C. It is understood that the Contractor has reviewed the schedule and has included in their bid sufficient monies to meet the schedule and will make no claim for extra compensation because of additional costs to meet scheduled dates.

D. The Contractor is advised that they will be directed to take remedial action as necessary to recover lost time on any critical items as determined from the Construction Schedule.

E. If it shall become imperative to perform Work at night, the County shall be informed at least 24 hours in advance Monday through Friday of Work proposed to be done during off hours. Temporary lighting and all other necessary facilities for performing and inspecting the Work shall be provided as required and as specified in Division 1, Section 01500, Temporary Facilities and Controls, or as directed by the Engineer.

F. Unless otherwise specifically permitted, all Work that would be subject to damage shall be stopped during inclement, stormy or freezing weather. Only such work that will not cause injury to workmanship or materials will be permitted. The Contractor shall carefully protect the Work against damage or injury from the weather, and when Work is permitted during freezing weather, provide and maintain approved facilities for heating the materials and for protecting the finished Work.

G. The Contractor shall require permission, in writing, to perform contractual work outside the regular County working hours of 7:00 AM to 3:30 PM, Monday through Friday, or on official County holidays. This written request should be received by the County Monday through Friday at least 24 hours in advance of beginning the work. The Contractor is responsible for coordination with the County Engineer and/or his duly authorized representative, prior to the start of the work to determine the dates of observance of the official County holidays that may occur during the course of the Contract. The official County holidays are:
   1. New Year's Day
   2. Martin Luther King, Jr. Day
   3. Lincoln's Birthday
   4. Washington's Birthday
   5. Memorial Day
   6. Independence Day
   7. Labor Day
   8. Columbus Day
   9. Election Day
   10. Veteran's Day
   11. Thanksgiving Day
   12. Friday after Thanksgiving Day
   13. Christmas Day

H. Failure of the Contractor to consider official County holidays during the preparation of their work plans and schedules shall not be cause for a delay claim against the County.

I. Contractor shall obtain permission from Owner, Owner's Representative and/or Plant management and staff prior to prosecuting any portion of the Work beyond the standard working days or hours. Should circumstances arise during the course of the Contract, where the Contractor works outside of the County's regular working hours (7:00 am to 3:30 pm, or as otherwise established for the project) or on weekends or official County holidays, regardless if this work is performed as a result of the Contractor's request or as required by the contract documents, or as required by the approved baseline schedule (resource loaded); the Contractor will reimburse the County for the cost of providing inspection and/or plant assistance, at the rate of $175 per hour per staff member. The Owner, Owner's Representative and Plant management and staff will review the scope of the operations and determine on a case-by-case basis the extent of construction oversight that may be required. Furthermore, failure of the Contractor to have considered such contingency cost in his bid price shall not be cause for an additional cost claim to the County.

1.6 WORK BY OTHERS

A. County will perform the following work:
   1. Operate all Aeration Tanks and all other pertinent existing plant valves and plant functions as deemed necessary.

1.7 REGULATORY AGENCY ACCESS TO CONSTRUCTION SITE

A. Whenever construction work is in progress or preparation, the Contractor shall permit access and inspection and shall provide proper and necessary facilities to the representatives of the County, Engineer and Regulatory Agencies including, but not limited to, the New York State Department of Environmental Conservation and the New York State Environmental Facilities Corporation.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

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SECTION 01020

ALLOWANCES

PART 1 – GENERAL

1.1 DESCRIPTION

A. The allowances described below are to provide specific services, materials or work related to new Aeration Blower Facility at the South Shore Water Reclamation Facility (WRF) – Contract No. S35121-06G.

B. The use of the allowances by the Contractor shall only be by written authorization or instruction from the Engineer and Owner.

C. Any amounts not expended at the completion of the work shall be deducted from the final payment to the Contractor.

D. A change order will be processed to increase the allowance if the amount becomes insufficient to complete the work of the Contract.

1.2 SCHEDULE OF ALLOWANCES

A. General Construction Contract:

1. Item 2: An allowance in the amount indicated in the Proposal for furnishing all labor, materials, equipment and incidentals for unforeseen conditions and associated additional work.

1.3 BASIS FOR PAYMENT

A. Item No. 2: the allowance for unforeseen conditions and associated additional work, as directed or authorized by the County, shall cover the cost of labor, materials, equipment and incidentals plus overhead and profit, computed in accordance with the requirements of the Agreement, Article XXII., "Extra Work".

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

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SECTION 01031

ADDITIONS, MODIFICATIONS AND ALTERATIONS TO EXISTING BUILDINGS AND STRUCTURES

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Work includes all labor, materials, equipment and appurtenances required for the complete execution of additions, modifications and alterations to existing buildings and structures as shown on the Drawings and specified.

B. The Contractor shall have examined all Work to be performed to the existing buildings and structures and familiarize himself with the nature and extent to which the existing buildings and structures will be damaged, items removed or re-arranged due to the Work under this Contract and that of other contracts.
   1. Cutting and patching shall conform to the requirements of the General Conditions, Article GC-29, "Cutting and Patching", and Section 01045, Cutting and Patching.
   2. Patching Work shall be performed with similar materials and in the same manner as adjoining Work. Joining between old and new Work shall be perfect and practically invisible. All due caution shall be taken to obtain a bond between old and new Work.

C. Major portions of the Work are indicated on the Drawings for the Contract and the accompanying Specifications thereto. All Work must be complete in all respects and executed with high quality workmanship.

D. Work to be performed due to damage caused by Contractor or his workers during demolition, removals, additions, modifications, and alterations that is not specifically indicated by details or general notes on the contract drawings may include the following:
   1. Removing loose rust, sealing or peeling paint from metal surfaces by scraping, sanding or wire brushing; priming and repainting metal surface (inside and outside) as specified under Section 09900, Painting.
   2. Cutting and modifying existing openings as necessary to receive new Work.
   3. Cleaning and repainting steel handrailing, brackets, sleeves, etc. Replacing existing railing with new aluminum railing, brackets, sleeves, etc.

E. The Contractor shall submit detailed description of methods and equipment and sequence for additions, modifications and alterations for Engineer's review.

1.2 SITE AND BUILDINGS

A. Prior to ordering any materials or doing any Work, the Contractor shall verify and be responsible for the correctness of all measurements, dimensions and other conditions of each building and structure scheduled for Work as necessary and required

1.3 MATERIALS

A. All materials to perform and complete the Work for Contract shall be new. Salvaged materials, such as brick, stone copings, granite sills, may be used under certain conditions subject to the approval of Engineer.

B. All salvaged materials shall be sound and undamaged. Materials to be re-used shall be stored and protected as directed by Engineer. Care shall be taken to prevent damage to materials or equipment to be re-used.

1.4 SHORING, UNDERPINNING AND BRACING

A. When necessary and required, the Contractor shall provide underpinning and temporary shoring and bracings, all in accordance with code requirements, the Drawings, and as approved by Engineer.

B. Shoring and bracing shall be of such form and so installed as to safely support the Work and interfere as little as possible with the progress of the Work. Suitable means shall be provided to adjust any settlement in the shoring supports. Temporary shoring shall consist of sound timbers or rolled shapes of required dimensions which shall be removed after necessity for same ceases to exist. All Work removed or damaged through installation of temporary shoring or through improper shoring shall be replaced or repaired after the shoring is removed, at no additional cost to the County.

1.5 WORK PREPARATION AND TEMPORARY ACCESS

A. The Contractor, before commencing Work shall prepare a Progress Schedule in accordance with the requirements of Section 01300, Additional Submittals and Section 01700, Maintenance of Plant Operations, in order to coordinate the Work of all trades and to insure completion on or before the completion date. The County and the Engineer reserve the right to revise or modify such schedules as required to expedite each phase of Work and to coordinate such Work with the partial use of the building for purposes as directed.

B. No facility such as toilets, corridors, etc., shall be barricaded or access restricted without providing other temporary or interim means of access. It is further required that no Work specified hereinafter shall disturb or interfere with the operation of

the existing mechanical installation until proposed new Work has been completed or satisfactorily installed. Exception may be made to this requirement only by written approval from County and Engineer.

C. Detailed sequence of availability of areas within the present buildings where Work is to be performed under each Contract shall be in accordance with Section 01700, Maintenance of Plant Operations, but may be modified by the Contractor, upon authorization by the County and Engineer as the Work progresses.

D. The General Construction Contractor shall furnish and install all temporary fire exits, fire extinguishers, hose and safety devices as may be required by authorities having jurisdiction.

E. Work within the existing building, once started, shall be completed as quickly as practicable and each trade shall determine before Work is started that all required materials are at hand or readily obtainable to avoid delays.

F. Shut-downs of existing services within existing buildings which may be occupied during construction will be permitted only upon approval by the County subject to at least sixty days notice in writing to the County in each case. Shut-downs will be limited to times which will result in the least interference with normal operations.

1.6 CUTTING, PATCHING, REPAIRING AND REFINISHING

A. The Contractor will be responsible for cutting all openings in walls, floors and ceilings (indicated to remain) to accommodate alteration Work under his Contract in accordance with the requirements of the General Conditions, Article GC-29, "Cutting and Patching" and Article GC-30, "Openings and Chases" and as hereinafter specified.
   1. Where new openings are to occur in existing exterior and interior concrete and masonry bearing walls and structural concrete floors, the Contractor will be required to notify the Engineer in writing and shall obtain approval prior to cutting operations. The Engineer will determine whether such openings affect the structural stability or load bearing capacities of the walls and the floors. Where embedded electrical conduits are known to exist, or where embedded conduits are found, the Contractor shall notify the County to determine if the conduit can be abandoned. If the conduit connects to equipment or lighting that must be maintained in service, the County will direct the Contractor to install temporary conduit and cable to maintain service until existing service is no longer required.
   2. Core drill for individual openings passing through existing concrete slabs. Obtain authorization from the County prior to core drilling. Prior to core drilling, the Contractor shall drill sufficient number of small exploratory holes to establish that the area to be core drilled is free of existing embedded conduits.

3. All holes and openings to be cut in existing walls, floors and ceilings of any nature shall be geometrically correct and no larger than necessary to accommodate the new Work.
4. No cutting of finished or structural Work may be done without the approval of the Engineer.

B. The Contractor shall be responsible for all finish patching operations of holes and openings in existing floors, walls, ceilings and roofs to accommodate the alteration Work under the Contract.

C. The Contractor and/or his Subcontractors shall provide and set in place all sleeves, forms and inserts required for their Work before new walls, partitions, floors and roofs are built. All cutting and patching of new walls, partitions floors and ceilings necessary for the reception of Work caused by failure to properly locate sleeves, forms and inserts or caused by incorrect location of Work shall be done at the expense of the Contractor involved, and shall require the approval of the Contractor whose Work is being cut, and the approval of the Engineer.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 01039

DEMOLITION AND REMOVAL OF EXISTING STRUCTURES
AND EQUIPMENT

PART 1 – GENERAL

1.1 GENERAL

A. Work Included:
   1. This Section covers the demolition, removal, and disposal of existing structures and equipment as indicated on the Contract Drawings and as specified hereinafter. The Contractor shall furnish all labor, materials and equipment to demolish structures and equipment and to remove fixtures, anchors, supports, piping and accessories designated to be removed on the Contract Drawings.
   2. The Contractor's attention is directed to the fact there may be hazardous materials present within existing structures, and equipment to be demolished, removed, and disposed that will require special handling and other safe guard measures in order to minimize chemical exposure hazards to site workers and to prevent environmental impacts to offsite areas.
   3. The removal of all equipment and piping, and all materials from the demolition of structure shall, when released by the Engineer, be done by the Contractor and shall become the Contractor's property, unless otherwise noted, for disposition in any other manner not contrary to the Contract requirements and shall be removed from the Site to the Contractor's own place of disposal.

B. Scheduling:
   1. Prior to commencement of work, the Contractor shall conduct a hazardous materials survey of all structures, and equipment to be demolished, removed and disposed, as shown on the Contract Drawings, in addition to the hazardous materials survey report provided in the Contract Documents. The survey shall include the identification, quantification, sample collection, and laboratory analytical testing of the following types of hazardous materials:
      a. Asbestos: An asbestos survey shall be performed by a New York State Department of Labor (NYSDOL)-certified Asbestos Inspector. The survey shall include suspect material sample collection and the subsequent laboratory analysis of these samples by a New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP)-certified laboratory. The asbestos survey will be performed in accordance with current federal and state asbestos regulations.
      b. Paint: A paint survey shall be performed by an Environmental Protection Agency (EPA)-certified Lead Inspector. The survey shall include paint chip sample collection and/or the use of an X-Ray

Fluorescence (XRF) analyzer to determine the presence of lead and polychlorinated biphenyls (PCBs) in paints. Paint chip sample analysis shall be performed by a NYSDOH ELAP-certified laboratory.

c. PCB-containing building materials: A survey of potential PCB-containing building materials (e.g., caulking and bitumastic coatings) shall be conducted by the Contractor. The survey shall include suspect material sample collection and the subsequent laboratory analysis of these samples by a NYSDOH ELAP-certified laboratory.

d. Mercury/PCB-containing fixtures and equipment: An inventory of potential mercury and PCB-containing fixtures and equipment shall be performed by the Contractor.

e. Survey Report: At the completion of the hazardous materials survey, the Contractor shall develop a survey report and submit it to the Engineer for review and approval prior to the commencement of work. The survey report shall include sample collection protocols and descriptions and estimated quantities of all materials that were sampled. In addition, the survey report shall include sample location drawings and laboratory analytical results for all samples collected.

2. The Contractor shall submit detailed description of methods and equipment and sequence for demolition and removal for the Engineer's review.

3. The Contractor shall proceed with the removal of the equipment, piping and appurtenances in a sequence designed to maintain the plant in continuous operation as described in Section 01700, Maintenance of Plant Operations, and shall proceed only after approval of the Engineer.

4. Any equipment, piping and appurtenances removed without prior authorization, which are necessary for the operation of the existing plant or of the plant expansion, shall be replaced to the satisfaction of the Engineer at no cost to the County.

C. Related Sections:
   1. Section 01355, Hazardous Materials Control.
   2. Section 01700, Maintenance of Plant Operations.
   3. Section 02050, Demolition, Removals and Modifications.

1.2 PROTECTION

A. General:
   1. Demolition and removal Work shall be performed by competent workmen experienced in the various types of demolition and removal work required and shall be carried through to completion with due regard to the safety of County employees, workmen on the Site and the public. The Work shall be performed with as little nuisance as possible.
   2. The Work shall comply with the applicable provisions and recommendation of ANSI A10.2, Safety Code for Building Construction, all governing codes and as hereinafter specified.
   3. The Contractor shall make such investigations, explorations and probes as are necessary to ascertain any required protective measures before proceeding

with demolition and removal. The Contractor shall give particular attention to shoring and bracing requirements so as to prevent any damage to new or existing construction.

B. Execution:
   1. The Contractor shall provide, erect and maintain catch platforms, lights, barriers, weather protection, warning signs and other items as required for proper protection of the public, occupants of the building, workmen engaged in demolition operations, and adjacent construction.
   2. The Contractor shall provide and maintain weather protection at exterior openings so as to fully protect the interior premises against damage from the elements until such openings are closed by new construction.
   3. The Contractor shall provide and maintain temporary protection of the existing structure designated to remain where demolition, removal and new Work is being done, connections made, materials handled or equipment moved.
   4. The Contractor shall take necessary precautions to prevent dust from rising by wetting demolished masonry, concrete, plaster and similar debris. Unaltered portions of the existing structures affected by the operations under this Section shall be protected by dustproof partitions and other adequate means.
   5. The Contractor shall provide adequate fire protection in accordance with local Fire Department requirements.
   6. The Contractor shall not close or obstruct walkways, passageways, or stairways and shall not store or place materials in passageways, stairs or other means of egress. The Contractor shall conduct operations with minimum traffic interference.
   7. The Contractor shall be responsible for any damage to the existing structure or contents by reason of the insufficiency of protection provided.

1.3 WORKMANSHIP

A. The demolition and removal Work shall be performed as described in the Contract Documents. The Work required shall be done with care, and shall include all required shoring, bracing, etc. The Contractor shall be responsible for any damage which may be caused by demolition and removal Work to any part or parts of existing structures or items designated for reuse or to remain. The Contractor shall perform patching, restoration and new Work in accordance with applicable technical sections of the Specifications and in accordance with the details shown on the Contract Drawings. Prior to starting of the Work, the Contractor shall provide a detailed description of methods and equipment to be used for each operation and the sequence thereof for review by the Engineer. All cutting and patching shall be performed in accordance with the requirements of the General Conditions, Article GC-29, "Cutting and Patching".

B. All supports, pedestals and anchors shall be removed with the equipment and piping unless otherwise specified or required. Concrete bases, anchor bolts and other

supports shall be removed to approximately one inch (1-in.) below the surrounding finished area and the recesses shall be patched to match the adjacent areas as shown. Wall and roof openings shall be closed, and damaged surfaces shall be patched to match the adjacent areas, as specified, as shown on the Contract Drawings, or as directed by the Engineer. Wall sleeves and castings shall be plugged or blanked off, all openings in concrete shall be closed in a manner meeting the requirements of the appropriate sections of the Specifications, as shown on the Contract Drawings and as directed and approved by the Engineer.

C. Wherever piping is to be removed for disposition, the piping shall be drained by the Contractor and adjacent pipe and headers that are to remain in service shall be blanked off or plugged and then anchored in an approved manner.

D. Materials or items to be demolished and not designated in Section 02050, Demolitions, Removals and Modifications, to become the property of the County or to be reinstalled shall become the property of the Contractor and shall be removed from the property and legally disposed of.

E. The Contractor shall execute the Work in a careful and orderly manner, with the least possible disturbance to the public and to the occupants of the structures.

F. Where alterations occur, or new and old Work join in, the Contractor shall cut, remove, patch, repair or refinish the adjacent surfaces to the extent required by the construction conditions, so as to leave the altered Work in as good a condition as existed prior to the start of the Work. The materials and workmanship employed in the alterations, unless otherwise shown on the Contract Drawing or specified, shall comply with that of the various respective trades which normally perform the particular items of work.

G. The Contractor shall finish adjacent existing surfaces of new Work to match the specified finish for new Work. The Contractor shall clean existing surfaces of dirt, grease, loose paint, etc., before refinishing.

H. Where existing equipment are indicated to be reused, the Contractor shall repair and refinish such equipment to put them in perfect working order. Refinishing shall be as specified in Section 02050, Demolitions, Removals, and Modifications, or and directed by the Engineer.

I. The Contractor shall remove temporary work, such as enclosures, signs, guards, and the like when such temporary work is no longer required or when directed at the completion of the Work.

1.4 CONDITION OF STRUCTURES AND EQUIPMENT

A. The County does not assume responsibility for the actual condition of structures and equipment to be demolished and removed.

B. Conditions existing at the time of inspection for bidding purposes will be maintained by the County so far as practicable.

C. The information regarding the existing structures and equipment shown on the Contract Drawings is based on visual inspection and a walk-through survey only. Neither the Engineer nor the County will be responsible for interpretations or conclusions drawn therefrom by the Contractor.

1.5 MAINTENANCE

A. The Contractor shall maintain the structures and public properties free from accumulations of waste, debris and rubbish, caused by the demolition and removal operations.

B. The Contractor shall provide on-site dump containers for collection of waste materials, debris and rubbish, and they shall wet down dry materials to lay down and prevent blowing dust.

C. At least once a week during the progress of the demolition and removal Work or as directed by the Engineer, the Contractor shall clean the Site and properties (including sweeping roadways with mechanical street sweeper), and dispose of waste materials, debris and rubbish.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

NO TEXT ON THIS PAGE

SECTION 01045

CUTTING AND PATCHING

PART 1 – GENERAL

1.1 GENERAL

A. This Section is supplementary to the requirements of the General Conditions, Article GC-29, "Cutting and Patching" and includes all cutting and patching of all Work under construction, completed Work and facilities installed by others, in order to accommodate the coordination of Work, install other Work, uncover Work for access, inspection or testing, or similar purposes. Demolition, removals and modifications work" is specified in Section 01039, Demolition and Removal of Existing Structures and Equipment. Execute all cutting and patching, including excavation, backfill and fitting required to:
   1. Remove and replace defective Work or Work not conforming to requirements of the Contract Documents.
   2. Remove samples of installed Work as required for testing.
   3. Remove all constructions required to provide for specified alteration or addition to Work by others.
   4. Uncover Work to provide for the Engineer's inspection of covered Work or inspection by regulatory agencies having jurisdiction.
   5. Connect to completed Work that was not accomplished in the proper sequence.
   6. Remove or relocate utilities and pipes installed by others which obstruct the Work to which connections must be made.
   7. Make connections or alterations to new facilities or facilities installed by others.

B. Restore all Work by others to a state equal to that which it was in prior to cutting and restore new Work to the standards of these Specifications.

C. Submittals:

   1. Prior to cutting, which may affect the integrity and design function of the Project, County's operations, or Work of another Contractor, submit written notice to the Engineer, requesting consent to proceed with cutting, including:
      a. Identification of the Project.
      b. Description of affected Work of Contractor and Work of others.
      c. Necessity for cutting.
      d. Effect on other Work and on structural integrity of the Project.
      e. Description of proposed Work. Designate:
         1) Scope of cutting and patching.
         2) Contractor, Subcontractor or trade to execute Work.
         3) Products proposed to be used.

4) Extent of refinishing.
5) Schedule of operations.

f. Alternatives to cutting and patching, if any.
g. Designation of party responsible for cost of cutting and patching.

2. Should conditions of Work, or schedule, indicate change of materials or methods, submit written recommendation to the Engineer, including:
   a. Conditions indicating change.
   b. Recommendations for alternative materials or methods.
   c. Submittals as required for substitutions.
3. Submit written notice to the Engineer, designating the time Work will be uncovered, to provide for observation. Do not begin cutting or patching operations until authorized by the Engineer.

D. Provide shoring, bracing and support as required to maintain structural integrity of the Project and protect adjacent Work from damage during cutting and patching.

E. Conform to all applicable Specifications for application and installation of materials used for patching.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 01050

FIELD ENGINEERING

PART 1 – GENERAL

1.1 GENERAL

A. The General Construction Contractor shall establish at least two bench marks for use by all Contractors, in accordance with the General Conditions, Article GC 28, "Layout and Levels" and the Agreement, Article XXIX, "Character and Competency" and Article XXX, "Superintendence". The Contractor shall comply with this article.

B. Contractor shall:
   1. Provide civil, structural or other professional engineering services specified, or required to execute Contractor's construction methods.
   2. Develop and make all detail surveys and measurements needed for construction including slope stakes, batter boards, piling and pier layouts and all other working lines, elevations and cut sheets.
   3. Keep a transit and leveling instrument on the Site at all times and a skilled instrument man employed or obtained whenever necessary for layout of the Work.
   4. Provide all material required for benchmarks, control points, batter boards, grade stakes, and other items.
   5. Be solely responsible for all locations, dimensions, and levels. No data other than written orders of the Engineer shall justify departure from the dimensions and levels required by the Drawings.
   6. When requested by Engineer, provide such facilities as may be necessary for the Engineer to check line and grade points placed by the Contractor. The Contractor shall do no excavation, backfill or embankment Work until all cross sectioning necessary for determining pay quantities has been completed and checked by the Engineer.

1.2 CONTRACTOR'S FIELD ENGINEER

A. The Contractor shall employ and retain at the Site of the Work a field engineer capable of performing all engineering tasks required of the Contractor. Tasks included are:
   1. A projection of Work to be completed the following day must be submitted to the CM by 4:00 PM of the preceding workday. This projection must include:
      a. Location of all areas in which construction will be done, including the Contractor and his Subcontractors.
      b. Major construction equipment utilized.
      c. Equipment and materials to be installed.
   2. Provide all surveying equipment required including transit, level, stakes and

required surveying accessories.

3. Furnish all required lines and grades for construction of operations. Check all formwork, reinforcing, inserts, structural steel, bolts, sleeves, piping, other materials and equipment.
4. Maintain field office files and drawings, Record Drawings, and coordinate engineering services with Subcontractors. Prepare Layout and Coordination Drawings for construction operations.
5. Check and coordinate Work for conflicts and interference and immediately advise the Engineer of all discrepancies noted.
6. Cooperate with the Engineer in field inspections, as required

1.3 QUALIFICATIONS OF SURVEYOR OR ENGINEER

A. A qualified engineer or registered land surveyor, acceptable to the Engineer.

1.4 RECORDS

A. Maintain a complete, accurate log of all control and survey Work as it progresses.

B. On completion of foundation walls and major Site improvements, prepare a certified survey showing all dimensions, locations, angles and elevations of construction.

1.5 SUBMITTALS

A. When requested by the Engineer, submit a certificate signed by a registered Engineer or surveyor certifying that elevations and locations of Work are in conformance with the Contract Documents. Explain all deviations.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 01072

REFERENCE STANDARDS

PART 1 – GENERAL

1.1 GENERAL

A. When a reference standard is specified, comply with the requirements and recommendations stated in that standard, except when they are modified by the Contract Documents, or when applicable laws, ordinances, rules, regulations or codes establish stricter standards. The latest provisions of applicable standards shall apply to the Work, unless otherwise specified. Reference standards include, but are not necessarily limited to, the following:

AMCA- Air Moving and Conditioning Association, Inc.

AASHTO - American Association of State Highway and Transportation Officials.

ABMA- American Boiler Manufacturers' Association

ACI - American Concrete Institute.

ACIFS- American Cast Iron Flange Standards.

AFBMA- Anti-Friction Bearing Manufacturers Association.

AGA- American Gas Association.

AGMA- American Gear Manufacturers Association.

AIA- American Institute of Architects.

AISC- American Institute of Steel Construction.

AISI- American Iron and Steel Institute.

ANSI - American National Standards Institute.

APA- American Plywood Association.

API- American Petroleum Institute.

ASCE- American Society of Civil Engineers.

ASME- American Society of Mechanical Engineers.

ASTM- American Society for Testing and Materials.

AWPA- American Wood Preservers Association.

AWS- American Welding Society.

AWWA- American Water Works Association.

CGA- Compressed Gas Association.

CRSI- Concrete Reinforcing Steel Institute.

CMAA- Crane Manufacturers' Association of America.

DIPRA- Ductile Iron Pipe Research Association.

EEI- Edison Electric Institute.

EJMA- Expansion Joint Manufacturers' Association.

Fed Spec - Federal Specifications.

FM- Factory Mutual.

HMI- Hoist Manufacturers' Institute.

IEEE- Institute of Electrical and Electronic Engineers.

IPCEA- Insulated Power Cable Engineers Association.

NACE- National Association of Corrosion Engineers.

NB- National Board of Boiler Pressure Vessels.

NBS- National Bureau of Standards.

NEC- National Electric Code.

NEMA- National Electrical Manufacturers Association.

NFPA- National Fire Protection Association.

NYSDOT - New York State Department of Transportation.

OSHA- Occupational Safety and Health Act.

PCA- Portland Cement Association.

PCI- Pre-stressed Concrete Institute.

RMA- Rubber Manufacturers' Association.

SMACCNA - Sheet Metal and Air Conditioning Contractors National Association.

SPI- Society of Plastics Industry.

SSPC- Steel Structures Painting Council.

STI- Steel Tank Institute

UL- Underwriters' Laboratory.

B. The Contractor shall, when required, furnish evidence satisfactory to the Engineer that materials and methods are in accordance with such standards where so specified.

C. In the event any questions arise as to the application of these standards or codes, copies shall be supplied on Site by Contractor.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

++ NO TEXT ON THIS PAGE ++

SECTION 01141

SITE UTILIZATION PLAN

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Site Utilization Plan requirements

1.2 SITE UTILIZATION PLAN REQUIREMENTS

A. Prepare a Site Utilization Plan (SUP) for each site showing staging areas, parking areas, stockpile areas, debris container areas, unloading areas, and trailer areas for review by the Owner and Engineer. The length and amount of meetings necessary to develop and adopt a SUP shall be as required.

B. Meeting(s) will be held at the site with all concerned parties to assist the Contractor in developing the criteria for the plan. During these meeting(s), all parties will present their needs and requirements for site utilization. As a minimum, each Contractor shall be allocated a portion of the available staging/parking/material storage area. Representatives from the local municipality or utility companies may be attending. The requirements of the local municipality and utility companies shall be incorporated into the SUP.

C. Prepare a draft site plan that attempts to incorporate the needs of all concerned parties. Another meeting will then be held at the site to review and present the plan. The plan shall then be revised at that meeting and adopted for use if it is acceptable to all relevant parties. If all parties cannot agree on an acceptable plan, then the Engineer will establish the Site Utilization Plan without any claims from the Contractor.

D. The Contractor shall understand the importance of a workable Site Utilization Plan and also understands that the Owner and Engineer may be required to select a plan to adopt that is not ideal to the planned construction activities anticipated before the bid was submitted. The Contractor shall not submit claims for damages associated with site utilization.

E. If a Site Utilization Plan as stipulated above is not prepared, then the Owner reserves the right to back charge the Contractor for the costs associated with having a Site Utilization Plan developed.

F. If the Contractor fails to participate or attend the meetings scheduled to develop the Site utilization Plan then the Contractor will forfeit any right to comment on the plan that is developed.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

++ END OF SECTION ++

SECTION 01150

MEASUREMENT AND PAYMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. Payment of the Work of the Contract will be made on the basis of the bid prices, as agreed upon and stipulated in the signed Contract Agreement. Payments include the furnishing of all labor, materials equipment and incidentals required to complete the work of the Contract as shown on the Contract Drawings and as specified.

B. A schedule outlining the procedures for measurement and payment for the contractor is included below. The schedule includes measurement and payment for the lump sum bid item and various unit price items only. For measurement and payment of Allowance items, the Contractor's attention is directed to Section 01020.

1.2 RELATED PROVISIONS SPECIFIED ELSEWHERE

A. Lump Sum Bid - Item No.1: Base Bid for furnishing all Labor, Materials and Equipment required for all Construction work ready for operation, inclusive of work covered under South Shore WRF Aeration Blower Facility:
   1. Measurement for payment of the Lump Sum Bid Item No. 1 shall be made in accordance with the Construction Agreement. The measurement shall be the percentage of work performed and in place as of the date of the payment request and shall be determined for each item included on the schedule of values. The measurement shall be documented by calculation of costs incurred, quantities in place, and invoices of materials and equipment supplied, as well as certification of the Contractor as to the accuracy of the measurement.
   2. Payment shall fully compensate the Contractor for furnishing all labor, materials, equipment and incidentals required to complete the work, as specified and shown in the Contract Documents, except for the allowance items listed in Section 01020 and unit price items, all as contained in the Bid Proposal and agreed upon in the Construction Contract.
   3. Payment of the lump sum shall also compensate the Contractor for insurance, bonds, furnishing and removing the temporary facilities as specified in Sections 01700 and 01500 and as shown on the drawings, and all other services required for the satisfactory completion of the work of this contract.

1.3 ALLOWANCES

A. Allowances will be paid in accordance with the provisions of Section 01020.

1.4 UNIT PRICE ITEMS

A. None

1.5 ESTIMATE OF QUANTITIES

A. None

1.6 RELATED PROVISIONS ELSEWHERE

B. Payments to the Contractor: Refer to the Agreement and the General Conditions.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

A. This Section specifies the general methods and requirements of submissions applicable to Shop Drawings, Product Data, Samples, Mock Ups, Construction Photographs, Construction or Submittal Schedules. Detailed submittal requirements are specified in the technical Sections.

B. All submittals shall be clearly identified by reference to Section Number, Paragraph, Drawing Number or Detail as applicable. Submittals shall be clear and legible and of sufficient size for presentation of data.

1.02 SHOP DRAWINGS, PRODUCT DATA, SAMPLES

A. Shop Drawings
   1. Shop drawings as specified in individual Sections include, custom-prepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shop work manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications, as applicable to the work.
   2. All shop drawings submitted by subcontractors shall be sent directly to the Contractor for checking. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.
   3. Check all subcontractor's shop drawings regarding measurements, size of members, materials and details to make sure that they conform to the intent of the Drawings and related Sections. Return shop drawings found to be inaccurate or otherwise in error to the subcontractors for correction before submission thereof.
   4. All details on shop drawings shall show clearly the relation of the various parts to the main members and lines of the structure and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted.
   5. Submittals for equipment specified under Divisions 13 through 16 shall include a listing of all installations where identical or similar equipment has been installed and been in operation for a period of at least one year.

B. Product Data
   1. Product data as specified in individual Sections include, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the manufacturer's product specification and installation instructions, availability of colors and patterns, manufacturer's printed statements of compliances and applicability, roughing-in diagrams and templates, catalog cuts, product

photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing and printed product warranties, as applicable to the work.

C. Samples
   1. Samples specified in individual Sections include, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols and units of work to be used by the Engineer or Owner for independent inspection and testing, as applicable to the work.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Review shop drawings, product data and samples, including those by subcontractors, prior to submission to determine and verify the following:
   1. Field measurements
   2. Field construction criteria
   3. Catalog numbers and similar data
   4. Conformance with related Sections

B. Each shop drawing, sample and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company name and signed by the Contractor: "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements." The cover sheet shall fully describe the packaged data and include a listing of all items within the package. Provide to the Resident Project Representative a copy of each transmittal sheet for shop drawings, product data and samples at the time of submittal to the Engineer.

C. The Contractor shall utilize a 9 character submittal identification numbering system in the following manner:
   1. The first five digits shall be the applicable Section Number.
   2. The next three digits shall be the numbers 001 to 999 to sequentially number each initial separate item or drawing submitted under each specific Section Number.
   3. The last character shall be a letter, A to Z, indicating the submission, or resubmission of the same Drawing, i.e., "A=1st submission, B=2nd submission, C=3rd submission, etc. A typical submittal number would be as follows:

03300-008-B		
03300	=	Section for Concrete
008	=	The eighth initial submittal under this section
B.	=	The second submission (first resubmission) of that particular shop drawing]

D. Notify the Engineer in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents. All cost associated with any deviations shall be borne by the Contractor.

E. The review and approval of shop drawings, samples or product data by the Engineer shall not relieve the Contractor from the responsibility for the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the Engineer will have no responsibility therefor.

F. No portion of the work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved shop drawings and data shall not be permitted. The Owner will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.

G. Project work, materials, fabrication, and installation shall conform with approved shop drawings, applicable samples, and product data.

1.04 SUBMISSION REQUIREMENTS

A. Make submittals promptly in accordance with approved schedule and in such sequence as to cause no delay in the Work or in the work of any other contractor.

B. Contractor shall reference the General Conditions for additional submission requirements.

C. Number of submittals required:
   1. Shop Drawings: See Article 1.05 below.
   2. Product Data: See Article 1.05 below.
   3. Samples: Submit the number stated in the respective Sections.

D. Submittals shall contain:
   1. The date of submission and the dates of any previous submissions.
   2. The Project title and number.
   3. Contractor identification.
   4. The names of:
      a. Contractor
      b. Supplier
      c. Manufacturer
   5. Identification of the product, with the section number, page and paragraph(s).
   6. Field dimensions, clearly identified as such.
   7. Relation to adjacent or critical features of the work or materials.
   8. Applicable standards, such as ASTM or Federal Standards numbers.
   9. Identification of deviations from Contract Documents.
   10. Identification of revisions on resubmittals.

11. A blank space suitably sized for Contractor and Engineer stamps as defined in the General Conditions.
12. Where calculations are required to be submitted by the Contractor, the calculations shall have been checked by a qualified individual other than the preparer. The submitted calculations shall clearly show the names of the preparer and of the checker.

1.05 ELECTRONIC DATA SUBMITTAL FORMAT

A. Files shall be electronically searchable based on Owner and Engineer established standard file naming convention.

B. Quality and Legibility: Electronic submittal files shall be made from the original and shall be clear and legible. Do not provide scans of faxed copies. Electronic file shall be made at the full size of the original paper documents. All pages shall be properly oriented for reading on a computer screen without rotating.

C. Organization and Content:
1. Each electronic submittal shall be one electronic file. Do not divide and submit individual submittals into multiple electronic files unless directed by Engineer.
2. When submittal is large or contains multiple parts, provide PDF file with bookmark for each section of submittal.
3. Submittal content shall include Contractor's letter of transmittal and Contractor's review and stamp.

D. Electronic file format:

PDF (Portable Document Format): .pdf, Adobe PDF documents; created through electronic conversion rather than optically scanned whenever possible.

1.06 REVIEW OF SHOP DRAWINGS, PRODUCT DATA, WORKING DRAWINGS AND SAMPLES

A. The review of shop drawings, data and samples will be for general conformance with the design concept and Contract Documents. They shall not be construed:
1. as permitting any departure from the Contract requirements;
2. as relieving the Contractor of responsibility for any errors, including details, dimensions, and materials.
3. as approving departures from details furnished by the Engineer, except as otherwise provided herein.

B. The Contractor remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.

C. If the shop drawings, data or samples as submitted describe variations and show a departure from the Contract requirements which Engineer finds to be in the interest of

the Owner and to be so minor as not to involve a change in Contract Price or Contract Time, the Engineer may return the reviewed drawings without noting an exception.

D. Submittals will be returned to the Contractor under one of the following codes.

Code 1 - "APPROVED" is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.

Code 2 - "APPROVED AS NOTED". This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

Code 3 - "APPROVED AS NOTED/CONFIRM". This combination of codes is assigned when a confirmation of the notations and comments IS required by the Contractor. The Contractor may, at his own risk, release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 14 calendar days of the date of the Engineer's transmittal requiring the confirmation.

Code 4 - "APPROVED AS NOTED/RESUBMIT". This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the package. This resubmittal is to address all comments, omissions and non-conforming items that were noted. Resubmittal is to be received by the Engineer within 14 calendar days of the date of the Engineer's transmittal requiring the resubmittal.

Code 5 - "NOT APPROVED" is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

Code 6 - "COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal which provide additional data to aid the Contractor.

Code 7 - “SUBMITTED FOR THE RECORD” is assigned when the contractor has submitted information for record purposes.

Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

E. Resubmittals will be handled in the same manner as first submittals. On resubmittals the Contractor shall identify all revisions made to the submittals, either in writing on the letter of transmittal or on the shop drawings by use of revision triangles or other similar methods. The resubmittal shall clearly respond to each comment made by the Engineer on the previous submission. Additionally, the Contractor shall direct specific attention to any revisions made other than the corrections requested by the Engineer on previous submissions.

F. Partial submittals may not be reviewed. The Engineer will be the only judge as to the completeness of a submittal. Submittals not complete will be returned to the Contractor and will be considered "Not Approved" until resubmitted. The Engineer may at his option provide a list or mark the submittal directing the Contractor to the areas that are incomplete.

G. Repetitive Review
   1. Shop drawings and other submittals will be reviewed no more than three times at the Owner's and Engineer's expense. All subsequent reviews will be performed at times convenient to the Owner and Engineer and at the Contractor's expense, based on the Owner's and Engineer's then prevailing rates. The Contractor shall reimburse the Owner and Engineer for all such fees invoiced to the Owner by the Engineer as defined in Article GC-18 of the General Conditions. Submittals are required until approved.
   2. Any need for more than one resubmission, or any other delay in obtaining Engineer's review of submittals, will not entitle Contractor to extension of the Contract Time.

H. If the Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, the Contractor shall give written notice thereof to the Engineer at least 7 working days prior to release for manufacture. If such notice is not received within 7 day the Contractor will not be eligible for a claim against the County for additional compensation.

I. When the shop drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.

1.07 DISTRIBUTION

A. Distribute reproductions of approved shop drawings and copies of approved product data and samples, where required, to the job site file and elsewhere as directed by the Engineer. Number of copies shall be as directed by the Engineer but shall not exceed six.

1.08 MOCK UPS

A. Mock Up units as specified in individual Sections, include but are not necessarily limited to, complete units of the standard of acceptance for that type of work to be used on the project. Remove at the completion of the work or when directed.

1.09 CONSTRUCTION PHOTOGRAPHS

A. The General Contractor shall have a total 300 color photographs made of the work during its progress and color photographs of the completed work. The photographs shall be of such views and taken at such times as the Engineer directs.

B. All photographic work shall be done by a qualified, established commercial photographer acceptable to the Engineer. Three prints of each photograph shall be furnished promptly to the Engineer, and each print shall have a glossy finish and be mounted in plastic sleeving on a substantial backing. The overall dimensions of each mounted print shall be 8-in by 10-inc by 1-1/4-inch flexible binding margin on the long top side to storage in standard 3-ring binders.

C. The film negative shall be retained in the files of the photographer until the completion of the project and shall then be turned over to the Owner Engineer.

D. Each photograph shall have attached to the backing a paper label, approximately 1-1/4-in wise by 1-3/4-inch high containing thereon in neat lettering:
   1. Contractor's name
   2. Short Description of View
   3. Photo Number and Date Taken
   4. Photographer's Firm Name

E. Requirements for job photographs are provided in Article GC-37 of the General Conditions.

F. If photographer takes digital pictures then all such pictures shall be provided, to the County, electronically on portable hard drive. Two (2) copies shall be provided.

1.10 PROFESSIONAL ENGINEER (P.E.) CERTIFICATION FORM

A. If specifically required in other related Sections, submit a P.E. Certification for each item required, in the form attached to this Section, completely filled in and stamped.

1.11 ADDITIONAL SUBMITTAL REQUIREMENTS

A. Additional Contractor submission requirements are included in Article GC-14 of the General Conditions.

1.12 GENERAL PROCEDURES FOR SUBMITTALS

A. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work of other related Sections, so that the installation will not be delayed by processing times including disapproval and resubmittal (if required), coordination with other submittals, testing, purchasing, fabrication, delivery

and similar sequenced activities. No extension of time will be authorized because of the Contractor's failure to transmit submittals sufficiently in advance of the Work.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

SUBMITTAL REVIEW CERTIFICATION FORM

The undersigned hereby certifies that he/she is a Professional Engineer registered in the State of New York and that he/she has been employed by

_____ to design
(Name of Contractor)

_____
(Insert P.E. Responsibilities)

in accordance with Section _____ for the

_____
(Name of Project)

The undersigned further certifies that he/she has performed the design of the _____,
(Name of Project)

that said design is in conformance with all applicable local, state and federal codes, rules, and regulations, and that his/her signature and P.E. stamp have been affixed to all calculations and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to the

Nassau County Department of Public Works
(Insert Name of Owner)

or Owner's representative within seven days following written request therefor by the Owner.

_____	_____
P.E. Name	Contractor's Name
_____	_____
Signature	Signature
_____	_____
Address	Title
	_____
	Address

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SECTION 01311

CONSTRUCTION SCHEDULING

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work shall consist of preparing, submitting, and maintaining a computerized CPM (Critical Path Method) progress schedule using Primavera P6 software.

B. The purpose of the computerized CPM progress schedule is to ensure timely completion of the contract and to establish a standard methodology for time adjustment analysis based on the principles of the Critical Path Method of Scheduling.

C. For this specification, 'Engineer' means County authorized Construction Manager.

D. The Contractor shall ensure that any and all computer files submitted to the Engineer are in a format that can be imported directly using Primavera software, version P6 (or as approved by the Engineer).

1.2 DETAILS

A. PRE CONSTRUCTION SCHEDULE MEETING

1. The Engineer will schedule and conduct a Pre-construction Scheduling Meeting with the Contractor within ten (10) working days after the contract has been awarded. The requirements of this specification will be reviewed at this meeting. Additionally, the following topics will be discussed:
    a. Specifics of any contract Time-Related Clauses.
    b. The representation in the schedule of the Time Related work.
    c. The calendar, activity coding, and resource definition requirements unique to and consistent with the contract.
    d. The Contractor's schedule methodology employed, proposed work sequence and any proposed deviations of sequences from the contract plans.
    e. The factors that the Contractor determines to control the completion of the project and any milestone completions contained therein.
    f. Narrative content for Initial Baseline and Monthly Updates.
    g. Schedule submission protocol for Initial Baseline and Monthly Updates.
2. The Contractors attendance at the Pre-construction Scheduling Meeting is mandatory. No field work will be allowed, with the exception of set up of the field office, until this meeting is held.

B. INITIAL BASELINE CPM CONSTRUCTION SCHEDULE

1. Within Fifteen (15) workdays following the Notice to Proceed, the Contractor shall prepare and submit to the Engineer the Initial Baseline CPM Construction Schedule for the entire project. This submission shall include the electronic Schedule file and paper reports as required and approved by the Engineer.
2. The Initial Baseline Schedule must be Cost and resource loaded and shall represent the Contractor's plan to construct the project. This schedule shall include all work and activities necessary to complete the project including but not limited to activities for the preparation, submittal, review, approval, fabrication, and delivery of all procurement related items. The Initial Baseline CPM Construction Schedule must be set up to conform to the staging/phasing and other requirements defined in or required by the contract.
3. The Initial Baseline Schedule shall meet all interim milestone dates and shall not extend beyond the contract completion date.

C. SCHEDULE REQUIREMENTS

1. The Contractors Initial Baseline CPM Construction Schedule shall meet the following requirements:
   a. CPM ACTIVITY NETWORK FORMAT - The schedule network shall use the Precedence Diagraming Method.
   b. PROJECT DEFINITIONS - The following project specific properties within the schedule shall be defined:
      1) CALENDAR - All calendars created shall encompass and account for the total duration of the contract time. The standard calendar shall be 8-hour days, five days per week and shall account for holidays and non-working days as defined in the contract documents. Additional calendars shall be created and included as required for:
         a. Work week (5 or 6 day). (When or if the contractor elects to utilize a 6-day work week they shall be responsible for the county's overtime costs as applicable by the contract requirements)
         b. Seasonal restrictions (asphalt, landscape, etc.).
         c. Concrete curing/calendar days.
         d. Shop drawing review.
         e. Any project specifics as required by the Engineer.
         f. Expected and contemplated weather conditions shall be accounted for in the schedule and described in the narrative.
      2. ACTIVITY CODE- As a minimum following activity codes shall be established:
         a. Responsibility - The party responsible for each activity. Only one party can be responsible for an activity. Include Values for "Nassau County Department of Public Works (NC)", "Prime Contractor" and third parties to the contract as appropriate (utilities, etc.).

b. Phase- Phasing consistent with Contract plans where each activity is performed; Include Values for “None”, and “Project Wide”.
c. Location - Location of activity work by Stationing; Include Value for “None”, and “Project Wide”.
d. Type- The type of work for each activity; Include a Value for Administrative”
e. Added Work- Work added to the Contract and incorporated into the schedule with the Engineers Approval.
f. As Required by Project - Any coding unique to or as required by the Engineer to facilitate the use and analysis of the Schedule. This coding shall be established in consultation with the Engineer at the Pre-construction Scheduling Meeting.

3. RESOURCES - The Resource Dictionary shall be established as required by the Engineer. The Resource Dictionary shall be limited to Labor and Equipment. Labor may be represented by work crews. The composition of each crew must be detailed and included as an appendix to the Narrative Report. Sub-Contractors shall be represented as a labor crew(s).
4. COST LOADING – Basis of cost loading will be the approved Schedule of Values.
5. ACTIVITY DATA
   a. ACTIVITY IDENTIFICATION - Each activity shall have a unique identifier. The identifier may be alpha-numeric, but at a minimum must be a unique number.
   b. ACTIVITY DESCRIPTION - Each activity shall be unambiguously described. Descriptions such as "construct 30% of Y” are unacceptable. Activities shall be discrete to the extent necessary to accurately schedule the work.
   c. ACTIVITY DURATION - Durations of individual work activities shall not exceed twenty (20) working days. The minimum activity duration increment is one full day. Durations of individual shop drawing review activities may exceed fifteen working days and shall be consistent with Contract Requirements. Exceptions to this will be reviewed by the Engineer on an activity-by-activity basis. If requested by the Engineer, production rates or other supporting information shall be supplied justifying the reasonableness of any given activity time duration. A Method Statement including the labor, equipment, production rates and any additional information, required to achieve a given activity shall be supplied within 5 working days when requested by the Engineer.
   d. ACTIVITY RELATIONSHIPS – Activity relationships shall be finish-to-start with no lags unless directed otherwise by the Engineer. Contractor requests for exemptions will be made on a case by case basis. Each activity except for the required

"Project Notice to Proceed" and "Completion" activities shall have a predecessor and a successor activity relationship.

e. ACTIVITY START and FINISH DATES - The earliest start date, earliest finish date, latest start date, and latest finish date shall be calculated for each activity.

f. ACTIVITY TOTAL FLOAT - The total float shall be calculated for each activity. Total float is the full amount of time by which the start on an activity may be delayed without causing the project to last longer.

g. ACTIVITY CALENDARS - The appropriate calendar assignment shall be made to each activity

h. ACTIVITY CODES - Coding shall be assigned to each activity from the defined activity dictionary. Each code shall have a value assigned in each activity.

i. ACTIVITY CONSTRAINTS - The start or completion of any activity shall not be constrained. Exceptions to this must receive prior approval in writing by the Engineer. A "Must¬ Finish-By" Date for the overall project is a constraint and must be pre-approved by the Engineer.

j. ACTIVITY RESOURCES- The schedule shall be "Resource" loaded as required by the Engineer. The resources required to accomplish each activity shall be assigned to that activity from the 'Resource Dictionary"

6. REQUIRED ACTIVITIES - The following activities shall be incorporated into the Schedule:

Activity ID	Activity Description	Activity Type	Logic Relationship
000010	Contract "Notice to Proceed"	Start Milestone	No Predecessors to this First Schedule Activity
999999	Completion	Finish Milestone	No Successors to this Last Schedule Activity

7. DATA DATE - The Data Date and Project Start Date in the Initial Baseline Schedule shall be the NOTICE TO PROCEED DATE. The Data Date for each Monthly Update shall be the first work day of the month.

D. REVIEW AND ACCEPTANCE OF THE INITIAL BASELINE CPM CONSTRUCTION SCHEDULE -

1. The Contractor shall submit to the Engineer the following items to facilitate review of the Initial Baseline CPM Construction Schedule:

a. Narrative- A statement explaining the general sequence of work in the Contractor's schedule, a detailed definition of the work on the Critical

Path, a statement regarding the meeting of any Time Restrictive Clause dates, and the explanation of any other ambiguities in the schedule.

2. The following Activity Reports generated from the software shall be provided or as required and approved by the Engineer:
   a. Critical Path Activity Sort - The activities that comprise the projects Critical Path. The list shall start with the first activity in the path and then ascend by Early Start date to the final activity in the path.
   b. Time Related Activity Sort - For the activities necessary to complete the work within each specific Time Frame provision in the contract, shall be listed. The list shall start with the first milestone activity and then ascend by Early Start date to the final milestone activity in the network comprising each Time Frame period. Include a Critical Path activity sort for each specific Time Frame in the contract.
   c. Constraint Activity Sort - Listing of Constrained Activities and type of constraint.
   d. Listing of Calendars and Activity Coding incorporated in the Schedule
3. Electronic copies of the Initial CPM Construction Schedule shall be provided in format approved by the Engineer.
4. The Engineer will review the Initial Baseline CPM Construction Schedule and forward any comments, revisions, or requests to the Contractor. Within ten (10) work days of the Engineer's reply, the Contractor shall make adjustment to the Initial Baseline CPM Construction Schedule in accordance with the Engineer's comments and resubmit copies for review consistent with the above directives.
5. Upon final revisions, the Contractor shall submit electronic file copies of the Initial Baseline CPM Construction Schedule to the Engineer. A sort of activities scheduled to start (ES) & finish (EF) in the next update period shall be included. The Logic Diagram shall be submitted as directed by the Engineer. The final submission shall be submitted for approval within five (5) work days of the Contractor's receipt of the final comments by the Engineer.
6. Approval of the Initial Baseline CPM Construction Schedule by the Engineer shall not be construed to imply approval of any particular method or sequence of construction or to relieve the Contractor of providing sufficient materials, equipment, and labor to guarantee completion of the project in accordance with the contract proposal, plans, and specifications. Approval shall not be construed to modify or amend the completion date. Completion dates can only be modified or amended by standard contractual means.
7. Failure to include in the Initial Baseline CPM Construction Schedule any element of work required for the performance of the contract shall not excuse the Contractor from completing all work required within the completion date(s) specified in the contract.

E. SCHEDULE UPDATES

1. MONTHLY PROGRESS UPDATES

   The Contractor shall update the schedule monthly. The schedule shall be updated to include all work and progress up to and including the last working

day of the month. This will establish the “Data Date”. The Monthly update shall detail progress based on actual dates of activities started and completed, the percent of work completed to date on each activity started but not yet completed and the status of procurement of critical materials. The updated schedule data shall be submitted in an electronic file format acceptable to the Engineer.

2. A Narrative Report is required for each update and shall provide the following information:
   a. Contractors transmittal letter to the Engineer stating the update period and schedule "Data Date".
   b. Work started, completed and ongoing during the update period by activity with “Actual Dates”.
   c. Description of current Critical Path and any change from previous Critical Path.
   d. Any activities added or deleted and any proposed changes in Activity Logic (Engineer’s approval in writing is required).
   e. Current Delays or Advancements
      1) Delayed or Advanced Activities.
      2) Proposed corrective action and schedule adjustments to address any Delays.
      3) Impact of Delays or Advancement on other activities (duration, ES, EF, LS, LF), milestone and completion dates.
      4) Impact of Delays or Advancement on the Critical Path.
   f. Outstanding Items that effect the schedule and status thereof (including but not limited to):
      1) Permits.
      2) Shop Drawings.
      3) Change Orders.
      4) Reviews of submittals.
      5) Approvals.
      6) Fabrication and Delivery.
   g. Scheduled Completion Date Status
      1) Contract Completion.
      2) Interim Milestones / Time Frame if any.
3. The following Activity Reports generated from the Software shall be provided:
   a. Current Critical Path Activity Sort
   b. Near Critical Activities Sort
   c. Report of Activities scheduled to start (ES) & finish (EF) in the next Monthly update period.
   d. Any other “Report” as directed by the Engineer and/or as discussed in the pre-construction scheduling meeting.
4. The Monthly Progress Updates shall be submitted to the Engineer within five (5) work days of the “Data Date”. The Engineer shall prepare a written response within five (5) workdays of receipt of the Monthly Update approving, approving with comments, or returning for resubmission within five (5) workdays. If the Contractor fails to comply with the Monthly Progress Update

submission requirements the Commissioner reserves the right to withhold any or all contract payments.

F. TOTAL FLOAT OWNERSHIP

Total Float belongs to the contract and shall not be considered as available for the exclusive use or benefit of either the County or the Contractor. Total Float is the number of days an activity may be delayed without extending the completion of either the project or an interim milestone. Float is available on a first-come, first-served basis to all identified "Responsible" parties in the schedule.

G. FLOAT MANIPULATION NOT PERMITTED

The Schedule shall not sequester float through such strategies as calendar manipulation, resource/labor manipulation or the extension of activity durations to fill up available float time. The Initial Baseline CPM Construction Schedule shall not attribute negative float to any activity.

H. CHANGES TO THE SCHEDULE

The Initial Baseline CPM Construction Schedule shall accurately reflect the way the Contractor intends to proceed with the project. Changes to the schedule (the addition or deletion of activities, logic changes, and duration changes) shall be submitted in writing to the Engineer for approval and inclusion in the next Monthly Progress Update. The process of comparing the Schedule Update to Baseline shall be followed throughout the contract. Revision to any contract milestones, or contractually mandated schedule provisions will not be permitted without written authorization from the Engineer.

I. CRITICAL ACTIVITIES AND BASIS FOR TIME ADJUSTMENTS

The measure for Time Adjustments in the schedule shall be based on the criticality, and responsibility of the delay or advancement. Criticality is defined as the presence of the delayed or advanced activity on the projects Critical Path. The Critical Path is defined to be the longest continuous chain of activities through the schedule network that establishes the minimum overall duration in the absence of constraints in the program software. Time adjustment does not mean an extension of time for this contract.

J. CHANGES TO THE CONTRACT

In the event a notice of a change to the contract is received the Contractor shall notify the Engineer in writing within 10 (ten) calendar days of the effect of such change to the schedule. Change to the contract includes, but is not limited to, extra work, change orders, work suspensions, changed condition, Value Engineering Change Proposal, etc. The effect of the change to the contract on the projects Critical Path shall be stated. Any proposed revisions to the Schedule to incorporate the change to the contract shall be stated. No changes shall be made to the Schedule without prior written approval of the Engineer. The approved changes shall be incorporated in the next Monthly Progress Update.

1.3 TIME IMPACT ANALYSIS

A. This analysis will be performed by the Engineer (CM's scheduler) based on schedule updates as accepted in monthly schedule updates.

B. Events, actions, and progress that cause delays or gains to the Project Schedule will be analyzed solely by the "Contemporaneous Period Analysis" method. The Contemporaneous Period Analysis evaluates delays or gains in the period in which it occurred. The analysis period for the purpose of this Specification shall be the period covered in each Monthly update to the schedule.

C. Impact of delay will be evaluated at the completion of the project. However, an interim extension of time for payment purposes only may be granted by the Commissioner at his or her sole discretion at the end of contractual completion date.

1.4 RECOVERY SCHEDULES

A. General Provisions for Recovery Schedules:
   1. When updated Progress Schedule indicates and the Engineer determines that the ability to comply with the Contract Times falls behind schedule due to delay attributed to the CONTRACTOR, the Contractor shall prepare and submit a Progress Schedule demonstrating responsible Contractor's plan to accelerate related work to achieve compliance with the Contract Times ("recovery schedule") for Engineer's acceptance.
   2. When recovery schedule will affect another prime Contractor on the Project, input on proposed recovery schedule action from the responsible prime Contractor must be provided within ten (10) workdays of such determination by the Engineer. Incorporate requirements of other prime Contractors into the recovery schedule to the extent applicable.
   3. Submit recovery schedule within 10 workdays after submittal of updated Progress Schedule where need for recovery schedule is indicated or include in next update as directed by the Engineer.

B. Implementation of Recovery Schedule:
   1. At no additional cost to OWNER, do one or more of the following: furnish additional labor, provide additional construction equipment, provide suitable materials, employ additional work shifts, expedite procurement of materials and equipment to be incorporated into the Work, and other measures necessary to complete the Work within the Contract Times.
   2. Item 1 above is also applicable when the Contractor is required to accelerate their Work to recover lost time
   3. Upon acceptance of recovery schedule by Engineer, incorporate recovery schedule into the next Progress Schedule update.

C. Lack of Action:

1. The Contractor's refusal, failure, or neglect to take appropriate recovery action, or the Contractor's refusal to submit a recovery schedule and take appropriate recovery action, shall constitute reasonable evidence that CONTRACTOR is not prosecuting the Work or separable part thereof with the diligence that will ensure completion within the Contract Times. Such lack of action shall constitute sufficient basis for OWNER to exercise remedies available to OWNER under the Contract Documents.

1.5 METHOD OF MEASUREMENT

The CPM (Critical Path Method) Progress Schedule will be measured for payment on a Lump Sum Basis.

1.6 BASIS OF PAYMENT

The lump sum price bid for the Critical Path Method Scheduling system shall include the cost of preparation and submission of the Initial Baseline Schedule and the preparation and submission of the monthly updates.

Payment will be made as follows:

A. Upon submission of the Initial Baseline CPM Construction Schedule 20%

B. Upon acceptance of the Baseline CPM Construction Schedule 20%

C. The balance will be paid in equal monthly payments distributed over the contract. These payments will be contingent on the submission of acceptable monthly updates. 60%

D. No additional payment over and above the lump sum price bid will be made for addition or deletion of work, delays, or any other reason whatsoever.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

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SECTION 01342

SAMPLES

PART 1 – GENERAL

1.1 GENERAL

A. Submittal of Samples shall conform to the requirements of the General Conditions, Article GC 15, "Samples" and to procedures described in this Section.

B. Samples and Shop Drawings which are related to the same unit of Work or Specification Section shall be submitted at the same time. If related, Shop Drawings and Samples are submitted at different times, they cannot be reviewed until both are furnished to the Engineer.

1.2 PROCEDURE

A. Submission of Samples shall conform to all applicable provisions under Shop Drawing Submittal and Correspondence Procedure.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

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SECTION 01355

HAZARDOUS MATERIALS CONTROL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope
   1. This section describes the minimum health, safety, and emergency response requirements for the activities at the site. Site activities may involve worker exposure to potentially hazardous materials.
   2. Contractor shall implement health and safety criteria and practices sufficient to protect onsite personnel, the public, and the environment from physical and chemical hazards particular to each site.
   3. The Contractor shall furnish all labor, materials, equipment, and incidentals to remediate any hazardous materials discovered during the performance of the work in this Contract.

B. References: Where conflicts arise between requirements of the regulatory requirements listed below, the most restrictive of the requirements shall be followed.
   1. 29 CFR 1910 OSHA Standards; General Industry
   2. 29 CFR 1910.120 OSHA Standards; Hazardous Waste Operations and Emergency Response
   3. 29 CFR 1926 OSHA Standards; Construction Industry
   4. DOT Standards and Regulations 49 CFR 171 Hazardous Materials Regulations; General Information, Regulations, and Definitions
   5. DOT Standards and Regulations 49 CFR 172 Hazardous Materials Tables and Military Standards
   6. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, ACGLH
   7. Guide to Occupational Exposure Values, ACGIH

C. Related Specifications
   1. Section 01356, Safe and Healthful Working Conditions.

1.2 REMEDIAL ACTION FOR UNFORESEEN HAZARDOUS MATERIAL

A. When remedial action is necessary for unforeseen hazardous materials, the Engineer will submit the scope of work in writing to the Contractor. The Contractor shall then obtain proposals for the work, including prices, from three separate County approved certified hazardous material remediation specialists, and submit them in writing to the Engineer within ten (10) consecutive calendar days of receiving the scope of work. The Engineer may select one proposal and direct the Contractor to engage the selected remediation specialist as a Subcontractor. Remediation work shall not commence until the Contractor receives written notice

from the Engineer to proceed with the work. All remediation work shall be performed by the certified remediation specialist.

B. Some of the remediation work may be critical to maintaining construction schedules. When this occurs, a time of completion shall be indicated in the scope of work submitted to the Contractor by the Engineer, and the work shall be subject to liquidated damages as set forth in the Agreement, Article XIV, "Liquidated Damages."

C. Disposal of wastes generated by remediation work will be based on the results of the testing performed by the Contractor. Disposal of remediated hazardous material must be at a site approved by the County and applicable state agency to accept such waste. The Contractor shall notify the Engineer at least fourteen (14) days prior to removal of the containers of hazardous material to allow for inspection of the containers and the hazardous waste manifest.

D. The Contractor shall submit written evidence that the receiving waste treatment, storage, or disposal facility to receive such waste by the EPA, DEC and State or local regulatory agencies. The Contractor shall also submit copies of the complete manifest, signed, and dated by the initial transporter, in accordance with Federal and State requirements. Completed and signed manifests from treatment or disposal facility shall be provided to the County within seven (7) days of disposal.

PART 2 – PRODUCTS

2.1 HEALTH AND SAFETY PLAN

A. The Contractor shall have a Health and Safety Plan (HASP) prepared, prior to the start of any construction. The HASP shall be available to workers on site and be submitted to the Engineer and County at least two weeks before the beginning of any field work. Copies of the plan shall be provided to the Contractors' insurers and their risk managers, if any, by the Contractor.
   1. The Contractor will abide by the work specific Health and Safety requirements as directed by the County.
   2. The provisions of the site HASP in no way relieves the Contractor of his primary obligation to provide for the safety of his employees and to ensure that all operations under this Contract are carried out so as to protect persons and property on the site and in the surrounding work area.

B. These minimum health and safety requirements are based on the potential for physical, biological, and chemical hazards associated with the work activities, including the potential exposure to hazardous materials that may be present. The HASP shall be prepared by a Certified Industrial Hygienist (CIH) who is qualified by training and experienced to perform this work. The HASP shall be submitted to the Engineer and County for review. The purpose of the HASP is to establish site-

specific health and safety requirements for protecting the health and safety of the Contractor and subcontractor personnel and visitors during all activities conducted on-site.

1. Construction activities which need to be addressed in the HASP include, but are not limited to:
   a. Soil excavation and grading.
   b. Demolition.
   c. Equipment installation.
2. The HASP shall include as a minimum the following items tabulated in Paragraph 2.1.E through Paragraph 2.1.S, below.

C. The Contractor shall identify an individual who shall serve as the Site Safety Officer for this project. The individual shall:
   1. Have a working knowledge of pertinent federal, state, and local health and safety regulations, program development and implementation, and air monitoring techniques.
   2. Be knowledgeable in tank cleaning procedures and protocols required by this project.
   3. Be certified as having completed training in first aid and CPR by a recognized, approved organization, such as the American Red Cross.
   4. Be continuously onsite during all operations covered by this Contract.
   5. Be familiar with the Site Health and Safety Plan and its requirements and be responsible for the Plan's implementation.
   6. The Site Safety Officer may designate an alternate to assist him, provided his alternate meets all of the above requirements. The Contractor shall submit the name, qualifications (education summary and documentation), and work experience of the Site Safety Officer, and any alternates to the Engineer prior to commencement of work at the site.

D. Personnel Qualifications (CIH): The Contractor shall identify an individual who shall serve as the CIH for this project. This individual shall:
   1. Have a minimum of three (3) years' experience in tank removal or hazardous waste field.
   2. Be familiar with all applicable OSHA, USEPA, and NYSDEC standards.

E. Standards and Regulations: The HASP shall be developed in accordance with the Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29, Code of Federal Regulations, Parts 1910 and 1926 (29 CFR 1910 and 1926) and all pertinent laws, rules, and regulations existing at the time of the work, including, but not limited to:
   1. Hazardous Waste Management System, Title 40 CFR 261-264.
   2. OSHA Standards, Hazardous Waste Operations and Emergency Response, Title 29 CFR 1910.120.
   3. OSHA Standards, Asbestos Regulations, Title 29 1910.1001.
   4. OSHA Standards, Subpart Z, Toxic and Hazardous Substance, Title 29 CFR 1926.58.

5. OSHA Standards, Title X, Lead in Construction, 1926.62.
6. EPA National Emission Standard for Hazardous Air Pollutants, National Emission Standard for Asbestos, Title 40 CFR, Part 51, Subpart M.
7. OSHA Standards, Hazard Communication, Title 29 CFR 1926.59.
8. OSHA Standards, Access to Employee Exposure and Medical Records, Title 29 CFR 1910.20.
9. OSHA Standards, Personal Protective Equipment, Title 29 CFR 1910.133.
10. OSHA Standards, Record Keeping, Title 29 CFR 1910.20.
11. OSHA Standards, Respiratory Protection, Title 29 CFR 1910.134.
12. The American National Standard Institute (ANSI) Practices for Respiratory Protection, ANSI Z38.2.
13. OSHA Standards, Ventilation, Title 29 CFR 1910.94.
14. ANSI Fundamentals Governing the Design and Operation of Local Exhaust System, ANSI Z9 2.
15. Hazardous Waste Management System, Title 6 NYCRR Parts 370-373.
16. Asbestos Safety Program Requirements, NYCRR Chapter 11, Title 10, Part 73.
17. Industrial Code Rule 56, NYCRR Title 12, Part 56.
18. Transportation Act, Title 49 CFR Parts 106, 107, 171-179.
19. New York State Solid Waste Hauling and Disposal Regulations, NYCRR Title 6, Parts 360 and 364.

F. Identification of Key Health and Safety Personnel and Alternates:
   1. List key personnel and alternates for site health and safety on a project responsibility chart, which includes phone numbers.
   2. Identify roles and responsibilities of key personnel.

G. Project Task/Operation Health and Safety Risk Analysis:
   1. Identify and describe the project tasks.
   2. Provide a hazard assessment of each project task, which shall include descriptions of potential chemical, biological, and physical hazards associated with the performance of the activity.
   3. Provide a description of health and safety mitigative actions for each project task which shall include, but not be limited to, administrative control, engineering control, safe work practice controls and personal protective equipment.

H. Personnel Training Requirements:
   1. Confirm that personnel are adequately trained to conduct their job responsibilities and handle the specific hazardous situations they may encounter during the project.
   2. Provide, as required, certification of personnel training and First Aid/Cardio-Pulmonary Resuscitation (CPR).
   3. Establish procedures and training for Hazard Communication Program in accordance with 29 CFR 1910.1200.

4. Provide information regarding training and experience of the person who will oversee excavation activities.

I. Personnel Protective Equipment (PPE) and PPE Reassessment Program:
   1. Describe the protective clothing and equipment to be worn by personnel during task-specific operations of the project.
   2. Describe the PPE reassessment program for the upgrading/downgrading of PPE levels associated with the task-specific operations of the project.
   3. Provide a written respiratory protection program and reassessment program, which shall be implemented during task-specific operations. The written program must include the procedure for proper section and use of respirators, instructions on proper cleaning, storage, and inspection of respirators.

J. Medical Surveillance:
   1. Describe the program for medical monitoring for each task-specific activity.
   2. Confirm and provide documentation, as applicable, that all project personnel are currently under a medical surveillance program.
   3. Provide documentation, as applicable, that all project personnel have respiratory clearance.

K. Site Control Measures:
   1. Define site control methods and site communications and include a site map delineating the control areas, if appropriate.
   2. Delineate the work area, including an exclusion zone (EZ), contamination reduction zone (CRZ) and the support zone, and describe the activities allowed in each zone.

L. Engineering Control Measures:
   1. Identify methods to control the generation of airborne particulates and volatile organic vapors during excavation of potentially contaminated soils.
   2. Identify engineering control of generation of lead-containing airborne particulates when impacting materials coated with lead paint.
   3. Identify engineering controls (e.g., tent enclosure, wetting of surfaces) to control generation of dusts when conducting dust-generating activities indoors (e.g., demolition of concrete foundations).

M. Decontamination Program:
   1. Establish decontamination procedures for personnel and equipment.
   2. The decontamination plan shall include provisions for hand wash facilities, and lunch/break areas, and a description of proper housekeeping practices.

N. Air Monitoring Program:
   1. Describe the area air monitoring program to be conducted during all intrusive site work, soil handling, and below-grade equipment installation, when works may be exposed to potentially contaminated soils. Minimum air monitoring

requirements must include continuous real time measurements for volatile organic vapors, hydrogen sulfide, dust, and LEL (methane).

2. Describe the area air monitoring program to be conducted during equipment removal and demolition affecting materials coated with lead paint when airborne dusts may be generated.
3. The air monitoring programs shall identify the analytical methodology required for each task-specific activity to ensure regulatory compliance.

O. Emergency Response/Contingency Plan:
   1. Describe instruction and procedures for evacuation of personnel.
   2. Describe instructions and procedures for methods of reporting fires. If the Contractor will be conducting activities such as welding, hot cutting or burning, or working with flammable materials such as paints, glues, and solvents, the Contractor shall provide a minimum of two Class ABC fire extinguishers (minimum 10 pounds) in the work area. The Contractor shall obtain a "Hot Works Permit" from the agency having authority and submit copies to the Engineer.
   3. Describe instructions and procedures for medical emergencies, including emergency notification and response procedures and a description of the route to the hospital.
   4. The medical emergency contingency plan shall include provisions for a minimum of two first aid kits (minimum 24-unit industrial first aid kit).
   5. Describe procedures addressing emergencies and equipment failures and barrier failures during work activities.

P. Surveillance Methods:
   1. Describe safety surveillance methods.
   2. Provide schedules of both walk-through surveys and in-depth safety audits to be performed on site.

Q. Safety Inspection Sheets:
   1. Provide safety inspection check-off sheets to be used on a regular basis in evaluation the site work and methods.

R. Safety Evacuation Drill: A quarterly evacuation drill shall be held in coordination with the existing plan alarm signal under the control of the Plant Chief. Conducting the safety drill shall be coordinated during regular scheduled work hours but timed to minimize disruption of major contract work. Upon evacuation, the Contractor shall immediately notify the Plant Chief and/or Resident Engineer that all personnel have evacuated.

S. Accident Prevention: An Accident Prevention Plan and description of work-phase safety plan shall be developed and written by a CIH. Each phase of the Accident Prevention Plan shall include a description of the work activity, probable hazards related to the work, and positive precautionary measures to be taken to safeguard against and reduce or eliminate each hazard. In the event of an accident/injury, the

Contractor shall immediately notify the Engineer. Within two working days of any reportable accident, the Contractor shall complete and submit to the Engineer an Accident Report.

T. The Contingency allowance provided in Section 01020, Allowances is intended to cover only those extra costs incurred by the Contractor in meeting County directed health and safety or remedial action requirements. It is not intended to fund the Contractor for the hiring of his own consultants nor to fund the costs of the Contractor's meeting obligations under OSHA.

PART 3 – EXECUTION

3.1 HAZARDOUS MATERIALS

A. There may be materials present at the project site that may pose chemical hazards to site workers during construction activities.

B. The Contractor shall be responsible for identifying suspect hazardous materials as they are encountered. Indication of the presence of hazardous materials, including odorous or stained soils and liquids, shall be immediately reported to the Engineer. If it is determined that the presence of hazardous material is not a threat to the health and safety of County to Contractor personnel, the Contractor shall continue planned work activities. Otherwise, the Contractor will be directed to take additional health and safety precautions as appropriate.

C. All non-disposable equipment that has been in contact with contaminated soils, lead-containing debris, or other hazardous materials, shall be cleaned prior to leaving the site. Equipment decontamination shall be performed in an area to be directed by the Engineer. The Contractor shall be responsible for containing all procedures within the perimeter of the designated decontamination area.
   1. The solid materials and rinse water collected as the result of the decontamination procedures shall be stored in appropriate containers on-site prior to disposal. Disposal of the wastes will be based on the results for testing performed by the Contractor and will be classified as non-hazardous or hazardous waste.
   2. Rinse water that does not meet the criteria for discharge to a POTW, shall be disposed of at an appropriate treatment and/or disposal facility.
   3. "Payment for disposal of the decontamination wastes shall be made from the Contingency Allowance item as described in Section 01020, Allowances.

3.2 MEDICAL SURVEILLANCE

A. Physical examinations for personnel working onsite shall be provided prior to project start-up. The examinations shall address the chemical and physical hazards to which the employees will be exposed. The medical examination results shall be

evaluated by a physician practicing occupational medicine to determine that the individual is medically qualified to wear a respirator and is physically fit for the work to be performed. The physician must certify that no physical condition or disease could be aggravated by exposure to the identified hazards. The results of the medical surveillance program shall be provided to the Engineer upon request.

3.3 PERSONNEL TRAINING

A. Personnel employed to sample tank residuals, perform hazardous materials remediation, and supervisors shall be trained and thoroughly familiar with the safety precautions, procedures, and equipment required for controlling the potential hazards associated with this project. This training shall be documented in detail and recorded in the project's records.

3.4 FIRST AID AND EMERGENCY RESPONSE EQUIPMENT AND PROCEDURES

A. The Contractor shall provide for appropriate emergency first aid equipment (including ANSI-approved eye wash stations, a portable stretcher, and an industrial-type first aid kit) suitable for treatment of exposure to site physical and chemical hazards. Additionally, two ABC-rated fire extinguishers shall be maintained on site as well absorbent material of sufficient quantity to as collect any spill which might occur during this project. A listing of emergency phone numbers and of contact for fire, hospital, police, ambulance, and other necessary contacts shall be points posted the Contractor's site. A route map detailing the directions to the nearest hospital also shall be posted.

3.5 HEAT AND COLD STRESS

A. The Contractor shall monitor all personnel for signs of heat or cold stress, as dictated by weather conditions. In addition, all field personnel shall be instructed to observe for symptoms of heat or cold stress in themselves and fellow workers and methods to control them. The Contractor shall adhere to guidelines provided in the Threshold Limit Values and Biological Exposure Indices published by the ACGIH for heat and cold extremes.

3.6 ILLUMINATION

A. Work areas shall be illuminated to a minimum of 10 foot-candles. Lighting shall be sufficient to determine whether material spills have occurred.

3.7 ELECTRICAL SAFETY

A. All electrical services must be grounded and equipped with and use ground fault circuit interrupter (GFCI) protected outlets. Portable lights used outside the Final Settling Tanks shall be suitable for hazardous locations and shall be connected to

extension cords equipped with connectors or switches approved for hazardous locations. Such equipment, when used, shall be inspected to ensure it will not be a source of ignition. All air monitoring instrumentation shall be rated as intrinsically safe for Class I, Division I, Group D atmospheres.

3.8 SITE CONTROL AND WORK ZONES

A. Personnel not directly involved with this project shall not be permitted to enter the work zone. For purposes of this Contract, the "Work zone" and Contractor's staging areas shall be the areas as shown on the drawings. The initial minimum level of PPE shall be in accordance with these Specifications. The boundary of the work zone shall be demarcated and posted clearly by the Contractor.

3.9 COMBUSTIBLE GAS/OXYGEN MONITORING

A. All tanks shall be monitored for the presence of combustible vapors prior to the start of project operations. Such monitoring shall be conducted both in the tanks and in the areas surrounding the tanks, especially in excavations.

B. If combustible gas monitoring shows that explosive levels within the tanks are less than 10% Lower Explosive Limit (LEL), those tanks may be removed and purged on the surface. However, if readings are at or above 10% LEL, the tank shall be monitored and purged in the ground, as outlined elsewhere in these Specifications.

C. Purging shall continue until monitoring shows readings below 10% LEL. Any reading above 10% LEL outside the tanks shall result in the suspension of operations until the situation is resolved, and retesting indicates the space is "safe" (explosive levels less than 10% LEL).

D. Also, oxygen levels shall be monitored in trenches and excavations prior to allowing workers to enter, and continuously during the time the workers are present in these spaces. Any reading less than 19.5% or greater than 23% oxygen shall prevent the workers from entering until the situation is resolved and retesting indicates the space is safe for entry.

E. Resolution of these hazardous situations may require forced ventilation of the space. Any combustible gas/oxygen monitor, provided it complies with these Specifications, may be selected.

F. The combustible gas indicator shall be calibrated, checked, and maintained daily as per manufacturer's directions.

3.10 AIR MONITORING AND SURVEILLANCE

A. When personnel are working on or near tanks or within trenches/excavations, the Contractor shall implement routine air surveillance and monitoring for LEL and

oxygen levels. Air monitoring and surveillance shall be required whenever personnel enter a trench/excavation, every fifteen (15) minutes during tank decontamination, or whenever site conditions indicate that fuel vapors are present. Air monitoring, when conducted, shall be performed in the breathing zone of the personnel. Air monitoring and surveillance equipment shall be described in the Health and Safety Plan.

3.11 ACTION LEVELS

A. Based upon published results of air monitoring and surveillance for combustible gas/oxygen monitoring for similar projects, the following action levels are recommended.
   1. Combustible Gas Monitoring
      a. 0 to 10% LEL: Normal operations, continue monitoring
      b. Greater than 10% LEL: Shut down operations and equipment; ventilate area
   2. Oxygen Monitoring
      a. 19.5% to 23% Oxygen: Normal operations, continue monitoring
      b. Less than 19.5% oxygen: Shut down operations and ventilate area
      c. Greater than 23% oxygen: Shutdown operations and ventilate area

3.12 EXCAVATION SAFETY

A. All demolition and excavating work shall be conducted in strict conformance with, at a minimum, 29 CFR 1926.650 through 29 CFR 1926.653, including requirements for sloping or shoring found in 29 CFR 1926.652. If the excavation must remain open during periods when the work site is unoccupied (i.e., overnight, over a weekend, and other similar off periods) barricades shall be placed around the excavation in such a manner to alert personnel to the danger and prevent them from falling into the trench (i.e. using road plates and barriers.)

3.13 CONFINED SPACE ENTRY

A. If any person is required to enter the tank or an excavation greater than 4 feet, it is considered a confined space entry. The medical surveillance shall ensure that the worker can enter a confined space. Workers required to enter confined space shall have the specialized training required under CFR 1910. 146 (Vol. 58, No. 9, January 14, 1993).

3.14 EATING, DRINKING, SMOKING

A. No eating, drinking, smoking, chewing of tobacco or gum, or other hand-to-mouth activities shall be permitted in any of the work areas during this project.

3.15 IGNITION SOURCES

A. Ignition sources (e.g., cigarette lighters, matches, or other flame producing items) not required for the completion of the project, shall not be permitted in the work zones. Before any work is done that might release vapors, work areas shall be barricaded and posted, and burning or other work shall be eliminated from the area where flammable vapors may be present or may travel. No work shall be done if the direction of the wind might carry vapors into areas where they might produce a hazardous condition, or when an electrical storm is threatening the site of work. Sparks caused by friction of electrostatic effects also may be a source of ignition in flammable atmospheres, especially at low humidity. Proper grounding of metal objects and/or electrical equipment, together with the use of sparkless tools and localized adjustment of humidity, may reduce this hazard.

3.16 BREAK AREA AND SUPPORT ACTIVITIES

A. All eating, drinking, smoking, and break facilities, as well as the Contractor's equipment storage, parking, and office shall be located outside the work zones as determined by the Site Safety Officer and approved by the Engineer.

3.17 SANITATION

A. The Contractor shall ensure that all onsite personnel have ready access to soap and clean water for washing and portable toilet facilities. The treatment plant washroom facilities usage is not permissible to the Contractor and crew.

3.18 UNFORESEEN HAZARDS

A. Should any unforeseen or site-specific safety-related threat, hazard, or condition become evident during the performance of work at this site, it shall be the Contractor's responsibility to bring such conditions to the attention of the Engineer both verbally and in writing as quickly as possible, for resolution. In the interim, the Contractor shall take prudent action to establish and maintain working conditions and to safeguard employees, the public, and the environment.

3.19 TERMINATION

A. Any disregard for the provisions of these Specifications shall be deemed just and sufficient cause for termination of the Contractor or any Subcontractor without compromise or prejudice to the rights of the Contractor.

++ END OF SECTION ++

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SECTION 01356

SAFE AND HEALTHFUL WORKING CONDITIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section describes the requirements for safe and healthful working conditions.

1.2 RELATED SPECIFICATIONS

A. Section 01355, Hazardous Materials Control

1.3 PAYMENT

A. No separate payment for the item "Safe and Healthful Working Conditions" will be made. The costs of same will be included in the Base Bid.

1.4 DEFINITIONS

A. Safety staff shall mean the safety professional and his safety representative(s) or the safety person.

1.5 SPECIAL CONDITIONS

A. In prosecuting the work of this Contract, the Contractor shall provide working conditions on each operation that shall be as safe and healthful as the nature of that operation permits. The various operations connected with the work shall be so conducted that they will not be unsafe or injurious to health; and the Contractor shall comply with all regulations and published recommendations of the New York State Department of Labor and all provisions, regulations and recommendations issued pursuant to the Federal Occupational Safety and Health Act of 1970 and the Construction Safety Act of 1969, as amended, and with laws, rules, and regulations of other authorities having jurisdiction, with regard to all matters relating to safe and healthful working conditions. Compliance with governmental requirements is mandated by law and considered only a minimum level of safety performance. All work shall also be performed in accordance with safe work practice.

B. The Contractor shall be responsible for the safety of the Contractor's employees, the public and all other persons at or about the site of the work. The Contractor shall be solely responsible for the adequacy and safety of all construction methods, materials, equipment and the safe prosecution of the work.

C. The Contractor shall employ a properly qualified safety professional familiar with all work under this contract whose duties shall be to initiate, review and cause implementation of measures for the protection of health and prevention of

accidents. The Contractor shall also employ full- time safety representative(s) whose sole duties shall be to work under the direct supervision of the safety professional, to implement the safety program for the work under this Contract.

D. The safety staff shall be provided with an appropriate office on the job site to maintain and keep available safety records, up-to-date copies of all pertinent safety rules, regulations and governing legislation, material safety data sheets, and the site safety plan including information concerning foreseeable emergency conditions, location of emergency and telephone contacts for supportive actions.

E. The Contractor shall stop work whenever a work procedure or a condition at a work site is deemed unsafe by the safety staff.

F. The Contractor and subcontractors shall be required to issue Photo Identification badges for each employee required to be on site. Badge shop drawings and updated logs showing employee names and badge numbers shall be issued to the Engineer for approval.

1.6 SUBMITTALS

A. The Contractor shall submit a Health and Safety Plan (HASP) as described in Section 01355, Hazardous Materials Control.

B. Within thirty (30) days of receiving a Notice to Proceed, the Contractor shall submit the name of a safety professional, employed by the Contractor, responsible for project safety management, and of the safety representative(s) who will work under his direction.

C. A resume, along with other qualifications, of the safety person or the safety professional and the safety representative(s), must be submitted to the Engineer for review and approval. The resume shall include such items as: experience, education, special safety courses completed, safety conferences attended and certification and registrations. Documentation and/or personal references confirming the qualifications may also be required. The persons proposed as safety person, safety professional or safety representative(s) may be rejected by the Engineer for failure to have adequate qualifications or other cause.

1.7 QUALIFICATIONS

A. Safety Professional: Recognition as a safety professional shall be based on a minimum of: Certification by the Board of Certified Safety Professionals as a Certified Safety Professional and five years of professional safety management experience in the types of construction and conditions expected to be encountered on the site.

B. Safety Representative: Qualifications of the safety representative(s) shall include a minimum of: five years of relevant construction experience, three years of which were exclusively in construction safety management, successful completion of a thirty (30) Hour OSHA Construction Safety and Health training course, 40 Hour OSHA Hazardous Materials training course, Confined Space training, and at least one year membership in the American Society of Safety Engineers.

C. Safety Person: Qualifications of the safety person must include a minimum of five years of relevant construction experience, two of which are related to safety management.

D. The safety staff shall be completely experienced with and knowledgeable of all applicable health and safety requirements of all governing laws, rules and regulations as well as of good safety practice. The safety staff shall not include the project manager, engineer, or superintendent, or anyone else working on the project. The safety staff shall have no other duties except those directly related to safety.

PART 2 – PRODUCTS

2.1 HEALTH AND SAFETY PLAN

A. The Contractor shall commit to writing a specific site health and safety plan before the start of any construction in accordance with Section 01355, Hazardous Materials Control.

2.2 ACCIDENT REPORTS

A. The Contractor shall promptly report to the Engineer all accidents involving injury to personnel or damage to equipment and structures, investigate these accidents and prepare required reports and submit a monthly summary of these accidents. The Contractor must submit a preliminary accident report to the Resident Engineer by the following day at the latest.
   1. The summary report, due by the 10th day of the following month, shall include descriptions of corrective actions to reduce the probability of similar accidents.
   2. In addition, the Contractor shall furnish to the Engineer a copy of all accident and health or safety hazard reports received from OSHA or any other government agency within one day of receipt.

B. In addition to the reports which the Contractor is required to file under the provision of the Workmen's Compensation Law, they shall submit to the Engineer on or before the tenth day of each month a report giving the total force employed on his Contract in man-days during the previous calendar month, the number and character of all accidents resulting in loss of time or considered recordable by

OSHA, and any other information on classification of employees, injuries received on the work, and disabilities arising therefrom that may be required by the Engineer.

1. The submittal shall also contain an audit report for the prior month, including the safety training conducted, the above equipment logs, records of the condition of the work areas, safety and health records, OSHA and ANSI Z16.1 incidence rates for frequency and severity of recordable accidents, and an evaluation of the effectiveness of the HASP with any changes necessary.
2. The safety professional (G) or safety person (E) and the Contractor shall sign this audit report. The Engineer will review these reports for Contractor's compliance with the safety provisions of the Contract.

2.3 SAFETY AND RESCUE EQUIPMENT

A. The Contractor shall have proper safety and rescue equipment, adequately maintained and readily available, for any foreseeable contingency. This equipment shall include such applicable items as: proper fire extinguishers, first aid supplies, safety ropes and harnesses, stretchers, water safety devices, oxygen breathing apparatus, resuscitators, gas detectors, oxygen deficiency indicators, combustible gas detectors, etc.

B. This equipment should be kept in protected areas and checked at scheduled intervals. A log shall be maintained indicating who checked the equipment, when it was checked, and that it was acceptable. This equipment log shall be updated monthly and be submitted with the monthly report. Equipment that requires calibration shall have copies of dated calibration certificates on site.

C. Substitute safety and rescue equipment must be provided while primary equipment is being serviced or calibrated.

2.4 PROTECTIVE EQUIPMENT

A. All personnel employed by the Contractor or his subcontractors or any visitors whenever entering the job site shall be required to wear appropriate personal protection equipment required for that area. The Contractor shall continuously provide all necessary personal protective equipment as requested by the Engineer for his designated representatives.

2.5 IDENTIFICATION BADGES

A. The Contractor shall submit shop drawings of Identification Badge to the Engineer for approval.

2.6 HOT WORK PERMIT

A. All hot work shall be in accordance with NFPA 51B.

B. The Contractor shall complete and submit the Nassau County Hot Work Permit included in this Section as Attachment 01356-A, located after the "End of Section" designation.

PART 3 – EXECUTION

3.1 SAFETY STAFF DUTIES

A. The safety professional shall visit and audit all work areas as frequently as necessary (a minimum of once a week) and shall be available for consultation whenever necessary. The safety staff shall have full authority to implement and enforce the health and safety plan to take immediate action to correct unsafe, hazardous or unhealthful conditions.

B. A member of the safety staff must be at the job site full time (a minimum of 8 hours per working day) whenever work is in progress. When multiple shift work is in progress more than one safety representative may be required.

C. The safety staff shall as a minimum:
   1. Schedule and conduct safety meetings and safety training programs as required by law, the safety plan, and good safety practice. A specific schedule of dates of these meetings and an outline of materials to be covered shall be provided with the safety plan. The Engineer shall be advised in advance of the time and place of such meetings. County personnel shall be invited to attend the meetings. All employees shall be instructed on the recognition of hazards, observance of precautions, of the contents of the safety plan and the use of protective and emergency equipment.
   2. Determine that operators of specific equipment are qualified by training and/or experience before they are allowed to operate such equipment.
   3. Develop and implement emergency response procedures. Post the name, address and hours of the nearest medical doctor, name and address of nearby clinics and hospitals, and the telephone numbers of the appropriate ambulance service, fire, and the police department.
   4. Post all appropriate notices regarding safety and health regulations at locations, which afford maximum exposure to all personnel at the job site.
   5. Post appropriate instructions and warning signs in regard to all hazardous areas or conditions, which cannot be eliminated. Identification of these areas shall be based on experience, on site surveillance, and severity of hazard. Such signs shall not be used in place of appropriate workplace controls.
   6. Ascertain by personal inspection that all safety rules and regulations are enforced. Make inspections at least once a shift to ensure that all machines, tools and equipment are in a safe operating condition; and that all work areas are free of hazards. Take necessary and timely corrective actions to eliminate all unsafe acts and/or conditions, and submit to the Engineer each day a copy

of his findings on the inspection check list report forms established in the safety plan.

7. Submit to the Engineer, copies of all safety inspection reports and citations from regulating agencies and insurance companies within one working day of receipt of such reports.
8. Provide safety training and orientation to authorized visitors to ensure their safety while occupying the job site.
9. Perform all related tasks necessary to achieve the highest degree of safety that the nature of the work permits.

3.2 VISITORS

A. All non-County personnel visitors that visit and tour the site shall sign the Visitors Log at the Plant's Administration Building, and sign waivers as directed by the County. The Resident Engineer must be aware of all tours/visits in conjunction with the Safety Evacuation Plan Protocol notification. All efforts should be made not to schedule site tours/visits at the time of scheduled evacuation drills.

3.3 ATTACHMENTS

A. The attachments listed below, following the "End of Section" designation, are a part of this Specification section.
   1. Attachment 01356-A, Hot Work Permit.

++ END OF SECTION ++

Nassau County Sewage Treatment Plant
Hot Work Permit

Hot Work Permit Job Information

Contractor Name: _____ Location of Hot Work: _____
Permit Authorizing Individual: _____ Phone: _____
Permit Issued (Date) _____ (Time) _____ AM/PM
Permit Expires (Date) _____ (Time) _____ AM/PM

Type of hot work to be used (Source of ignition): ❑ Grinding ❑ Cutting ❑ Brazing or Soldering
❑ Welding/Burning ❑ Heating ❑ Other_____

PPE to be Used by Person Performing Hot Work: _____

Describe the Hot Work Job and Materials to be Worked on: _____

Any special hazards and/or special precautions to be taken: _____

Fire Watch Required? ☐ **Yes** ☐ **No** **Number of Fire Watches Required:** ____

Acknowledgement of Permit Review by Person Performing Work or Crew Supervisor

Acknowledgment: I participated in the work site preparation, coordinated with the PAI, reviewed this Hot Work Permit and I fully understand the work to be performed and my responsibilities. The person(s) performing the hot work understand that this permit is valid only so long as work conditions existing at the time of issuance do not change. They will stop the work and notify the PAI of any change in work area conditions which adversely affects safety. I or the person(s) performing the work are adequately trained in the safe handling and use of their equipment and applicable regulatory requirements.

Worker/Supervisor: _____ **Signature:** _____
Company: _____ **Date:** _____

Permit Authorizing Individual (PAI) Authorization

I completed the site inspection, notified the person performing the work or their crew supervisor about flammable materials or hazardous conditions which may not be obvious, and verified that the person performing (or directly supervising the crew performing) hot work has reviewed the permit and signed the acknowledgment above. (If no, hot work is not permitted)

Signature: _____ **Date:** _____

Notice: Post this permit in Hot Work Permit area until permitted operations are complete. Upon Completion return permit to the PAI.

Final Inspection (Fire Watch, or PAI if No Fire Watch Was Required)

I completed final inspection at the required times after completion of Hot Work and observed no signs of smoldering or combustion.

Signature: _____ **Date:** _____ **Time:** _____ (Day 1)

Day	PAI Signature	Date/Time	Acceptable		Final Insp./ Initials	Comments
			Yes	No		
2						
3						
4						
5						
6						
7						

- Permit Authorizing Individual (PAI) - The individual designated by management to authorize hot work
- Conducts inspection to verify that safeguards are in place based on site-specific conditions of flammable/ combustible materials, hazardous processes, or other potential fire hazards in the work location.
- Ensure fire protection and extinguishing equipment are available and properly located at the site.
- Verify a fire watch is at the site, if required.
- Issues a Hot Work Permit (HWP), when required.

Hot Work Required Precautions Checklist

1) Inspect work area and confirm that applicable precautions have been taken in accordance with NFPA 51B (by PAI After Coordination With & Setup By Person Performing Hot Work; initially and when revalidating):
2) All sprinkler and/or other fire suppression systems in the Hot Work Permit area operational.
3) Cutting/welding equipment in good repair, free of damage or defects.
4) Persons conducting hot work have been trained.
5) All facility employees or other parties that may be potentially affected by the hot work have been notified.

REQUIREMENTS WITHIN 35 FEET OF WORK (HORIZONTAL & VERTICAL)

1) Flammable liquids and combustible dust/lint/oil deposits/trash removed or shielded with fire-retardant material.
2) Flammable vapor sources removed or flammable vapor properly tested and found to be well below the LEL.
3) Combustible flooring properly wetted, wet sanded or shielded.
4) Combustible walls, ceilings, partitions or roofing properly shielded.
5) Covers under work to keep sparks from lower levels and shielding/partitions to protect passer-by.

WORK ON WALLS OR CEILINGS

1) Combustibles have been moved away from opposite side. (If no, hot work is not permitted)
2) No combustible covering, interior (for sandwich-type panel) or other combustible content.
3) Danger from conduction of heat to adjacent rooms eliminated.

WORK ON ENCLOSED EQUIPMENT (Tanks, Containers, Ducts, Dust Collectors, etc.)

1) All duct and conveyor systems properly protected or shut down.
2) Equipment is cleaned of all combustibles, flammable vapors, liquids, or dusts. (If a flammable vapor source, conduct vapor monitoring)

FIRE WATCH

1) Required for the following: (a) Torch work (b) Combustibles within 35' (c) Combustibles >35', but easily ignited, (d) Wall/floor openings expose adjacent/concealed combustibles, (e) Conduction through metal can ignite other side (f) Potential for more than a minor fire.
2) Charged, inspected, operational fire extinguishers of an appropriate type are present.
3) Fire Watch trained in extinguisher and emergency alarms (fire alarm, telephone, or radio).

OTHER PRECAUTIONS

1) Work in a confined space requires Confined Space Entry Permit prior to hot work permit approval.
2) Is continuous atmospheric monitoring, smoke detection or heat detection warranted?
3) Ample ventilation exists or provisions made for continuous ventilation to remove smoke/vapor from work area
4) Process equipment/piping purged, disconnected and blanked in accordance with Lockout/Tagout procedures.
5) Do conditions require Re-Validation more than every 24 hr.?

SECTION 01370

SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. Submit a Schedule of Values allocated to the various portions of the work, within twenty (21) days after the effective date of the Agreement.

B. Upon request of the Engineer, support the values with data which will substantiate their correctness.

C. The accepted Schedule of Values shall be used only as the basis for the Contractor's Applications for Payment.

1.2 RELATED REQUIREMENTS

A. General Conditions of the Construction Contract

1.3 FORM AND CONTENT OF SCHEDULE OF VALUES

A. Contractor's standard forms and automated printout will be considered for approval by the Engineer upon Contractor's request. Identify schedule with:
   1. Title of Project and location.
   2. Engineer and Project number.
   3. Name and Address of Contractor.
   4. Contract designation.
   5. Date of submission.

B. Schedule shall list the installed value of the component parts of the work in sufficient detail to serve as a basis for computing values for progress payments during construction.

C. Identify each line item with the number and title of the respective Section.

D. For each major line item list sub-values of major products or operations under the item.

E. For the various portions of the work:
   1. Each item shall include a directly proportional amount of the Contractor's overhead and profit.
   2. For items on which progress payments will be requested for County approved stored materials, break down the value into:

1. a. The cost of the materials, delivered and unloaded, with all taxes paid. Paid invoices are required for materials upon request by the Engineer.
2. b. The total installed value.

F. The sum of all values listed in the schedule shall equal the total Contract Sum.

1.4 SUBSCHEDULE OF UNIT MATERIAL VALUES

A. Submit a sub-schedule of unit costs and quantities for:
   1. Products on which progress payments will be requested for County approved stored products.

B. The form of submittal shall parallel that of the Schedule of Values, with each item identified the same as the line item in the Schedule of Values.

C. The unit quantity for bulk materials shall include an allowance for normal waste.

D. The unit values for the materials shall be broken down into:
   1. Cost of the material, delivered and unloaded at the site with all taxes paid.
   2. Copies of invoices for component material shall be included with the payment request in which the material first appears.
   3. Paid invoices shall be provided with the second payment request in which the material appears or no payment shall be allowed and/or may be deleted from the request.

E. The installed unit value multiplied by the quantity listed shall equal the cost of that item in the Schedule of Values.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01400

PROTECTION OF UTILITIES

PART 1 – GENERAL

1.1 WORK INCLUDES

A. Work includes all labor, materials, equipment, and incidentals required to mark out and protect all public or private utilities, including concrete encased piping, within or adjacent to the Contract area.

B. The Contractor is specifically directed to become familiar with the existence of aerial, surface, or subsurface structures of municipal and other public or private service corporations within the construction site.

C. A careful search has been made, in good faith, and known public or private utilities within or adjacent to the Contract area are shown in their approximate locations on the Contract Plans. However, there is no guarantee that all existing utilities have been found. All utilities may not be shown on the Contract Drawings.

D. The Contractor's attention is also directed to the fact that during the life of the plant, the County and operators of utilities may make changes in their facilities.

E. The Contractor shall determine the exact locations and elevations of all pertinent structures, utilities and facilities before construction work and new installations commence.

F. Conflict between existing structures, utilities and facilities and new work shall be ascertained by the Contractor and called to the attention of the Engineer.

G. The Contractor shall cooperate with the County and public utility corporations whose structures (aerial, surface or subsurface) are within the limits of or along the outside of the construction areas to make it possible for them to maintain uninterrupted service.

H. The Contractor shall conduct operations in such a way as to delay or interfere as little as practicable with the work of utility corporations.

I. The Contractor shall give the County and public utility corporations involved reasonable notice, but not less than 48 hours in advance of operations, which may or will affect their structures.

J. The Contractor shall protect, in a suitable manner, all utilities encountered, including concrete encased piping, and shall repair any damage to structures, utilities and facilities caused by operations.

1. If the nature of the damage is such as to endanger the satisfactory functioning of the utilities and necessary repairs are not immediately made by the Contractor, the work may be done by the respective owning companies and the cost thereof charged against the Contractor.

K. The Contractor shall take these conditions into consideration in making up the bid.

L. It is understood and agreed that the Contractor has considered in his bid all of the permanent and temporary utility appurtenances and that no additional compensation will be allowed for any delays, inconveniences or damage sustained by him due to any interference from the utility appurtenances.

1.2 PUBLIC AND PRIVATE UTILITY MARKOUTS

A. The Contractor shall be required to provide utility mark outs for all private and public utilities. The limits for these mark outs shall be the project limit shown on the Engineering Drawings. The Contractor shall submit the proposed utility subcontractor for approval.

1.3 MEASUREMENT AND PAYMENT

A. No separate payment for the items "Protection of Utilities" will be made. The costs of same shall be included in the Base Bid.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01410

JOB PHOTOGRAPHS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope of Work:

1. The Contractor shall engage the services of an experienced photographer, approved by the County, to take color job photographs and video as detailed under these specifications.
2. The photographer will be required to take preliminary photographs of the site prior to the commencement of work as directed by the Engineer.
3. Subsequent photographs as determined by the Engineer shall be taken during the construction phase.
4. The photographer shall visit the site prior to the start of construction, then every other week as the work progresses, additional visits may be required.
5. The quantities of job photographs specified herein supersede the quantities specified in the General Conditions, Article GC-37, Photographs.

1.2 MEASUREMENT AND PAYMENT

A. No separate payment for the item "Job Photographs" will be made. The costs of same shall be included in the Lump Sum, Base Bid.

B. If less than one thousand (1,000) photographs are required, the Contractor shall credit the County fifteen dollars ($15.0) for each photograph under one thousand (1,000) photographs; should more than one thousand (1,000) photographs be required, the Contractor will be paid fifteen dollars ($15.0) for each photographs over one thousand (1,000) photographs.

PART 2 – PRODUCTS

2.1 PHOTOGRAPHS

A. A photograph shall be defined as one exposure.

B. A total of one thousand (1,000) photographs at the site shall be taken.

C. The County shall reserve the right to reject any photograph that is not clear or definitive. Any photograph so rejected shall be subtracted from the total exposures before computations for payment or credit under this section.

D. The prints, slides and negatives shall be suitably mounted and labeled in loose-leaf type binders, which have protective covers for the prints, slides, and negatives.

E. The prints shall have indelibly printed on their reverse side of the following:
   1. Project Number
   2. Project Name
   3. Contract Number and Description
   4. Job Number
   5. Photo Number
   6. View and description indicating location of camera, general description of what photograph represents, and indicate this is a preliminary photograph. (A plot plan shall be submitted by the Contractor indicating location and photo number of all preliminary photographs.)
   7. Date picture was taken.
   8. Name of photographer and photographer's firm.
   9. Contractor's name.

F. An electronic copy containing all photos taken at the site shall be supplied on CD and submitted to the Engineer for approval. Provide 2 copies of the CD.

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01416

SPECIAL INSPECTIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified and required to cooperate with the Coordinating Special Inspector and individual special inspectors employed by County, and to perform required testing and inspections. County shall engage the services of testing agencies as needed to facilitate Special Inspections.
   2. Supplement A, Statement of Special Inspections, included with this Section, lists testing and inspection divisions. The Statement of Special Inspections has been prepared by the Structural Engineer of Record (SER) for the project.

1.2 DEFINITIONS

A. Special Inspector: Professional engineer or architect, hired by County, registered in the same state as the Site, responsible for coordinating and verifying the inspection and testing required by the Statement of Special Inspections included in this Section and reporting to the Building Official.

B. Building Official: Officer or other designated authority having jurisdiction charged with the administration and enforcement of the governing code, or a duly authorized representative.

C. SER: The Structural Engineer of Record (SER) is the Registered Design Professional in Responsible Charge of the structural system. The SER is responsible for preparing the Statement of Special Inspections (SSI) for the structural elements subject to inspection and testing.

D. Special Inspections: Testing and inspection required in the Statement of Special Inspections, prepared by the SER.

1.3 QUALITY ASSURANCE

A. County will employ and pay for services of the Special Inspector, who will have a minimum of five years of experience in managing, monitoring, and inspecting building construction.

B. Special Inspections shall be in accordance with applicable building code Laws and

Regulations, and the Statement of Special Inspections, prepared by the SER.

C. Inspectors shall be qualified in their assigned Special Inspection in accordance with the Statement of Special Inspections, prepared by the SER.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Samples: Representative Samples of materials when required or requested by County / Special Inspector.

B. Informational Submittals: Submit the following:
   1. Completed Supplement D, Fabricator's Certificate of Compliance, as attached to this Section, for fabrication of structural steel.
   2. Site Quality Control Submittals: Material test reports.
   3. Qualification Statements: Names and qualifications of each testing agency employed, and qualifications of testing agency's personnel that will perform testing as required in the Statement of Special Inspections, prepared by the SER.

1.5 Contractor's RESPONSIBILITIES

A. Provide safe access to Work to be tested and inspected.

B. Protect test samples left at designated area on Site.

C. Facilitate inspections and tests.

D. Provide access to Suppliers' and Subcontractors' operations as required.

E. Notify testing agencies, Special Inspector, and County sufficiently in advance of the Work for the testing agencies, Special Inspector, and County to coordinate their personnel at the Site. Do not cover Work to be inspected until Special Inspections have been completed and accepted.

F. Special Inspections required in this Section do not supersede or make unnecessary inspections and tests required under other Specification Sections or standard inspections required by Laws and Regulations.

G. Provide the completed Statement of Special Inspections to the local Buiding Official when obtaining the Building Permit.

1.6 SPECIAL INSPECTOR's RESPONSIBILITIES

A. Special Inspector will:
   1. Review testing agencies and testing personnel, relative to conformance to the Statement of Special Inspections, and in accordance with Laws and Regulations.
   2. Complete Supplement A, Statement of Special Inspections, of this Section to provide names of each inspector and testing agency for each Special Inspection required. Review completed Statement of Special Inspections, prepared by SER for general conformance with the current State Building Code.
   3. Coordinate activities of individual inspectors and testing agencies with Contractor.
   4. Provide interim reports of inspections and material testing to Building Official, County.
   5. To obtain certificate of use and occupancy from the Building Official, complete and provide to the Building Official, County, Supplement B, Final Report of Special Inspections, of this Section, documenting completion of Special Inspections and correction of discrepancies noted in the Special Inspections.

1.7 INSPECTOR RESPONSIBILITIES

A. Perform specified inspections, sampling, and testing of materials and methods of construction; review and ascertain compliance with Laws and Regulations.

B. Promptly notify Special Inspector, County, and Contractor of irregularities or deficiencies in the Work observed during Special Inspections. Corrective action, if required, will be determined by County.

C. Promptly submit two copies each of reports of inspections and tests to Special Inspector, County, and Contractor including:
   1. Date issued.
   2. Project title and number.
   3. Name and signature of inspector.
   4. Date of inspection or sampling and test.
   5. Record of temperature and weather.
   6. Identification of product and Specification Section.
   7. Location in Project.
   8. Type of inspection or test.
   9. Location of inspection or test within project.
   10. Results of inspections and tests, and observations regarding compliance with Laws and Regulations, and standards.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 SUPPLEMENTS

A. The supplements listed below, following the "End of Section" designation, are part of this Section:
   1. Supplement A – Statement of Special Inspections
   2. Supplement B – Final Report of Special Inspections
   3. Supplement C – (Not Used)
   4. Supplement D – Fabricator's Certificate of Compliance

+ + END OF SECTION + +

Supplement A - Statement of Special Inspections

Project:

Location:

Owner:

Design Professional in Responsible Charge:

This *Statement of Special Inspections* is submitted as a condition for permit issuance in accordance with the Special Inspection and Structural Testing requirements of the Building Code. It includes a schedule of Special Inspection services applicable to the Project as well as the name of the Coordinating Special Inspector and the identity of other approved agencies to be retained for conducting these inspections and tests. This *Statement of Special Inspections* encompass the following disciplines:

☒ Structural ☐ Mechanical/Electrical
☒ Architectural ☐ Other: _____

The Coordinating Special Inspector shall keep records of all inspections and shall furnish inspection reports to the Building Official and the Registered Design Professional in Responsible Charge. Discovered discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected, the discrepancies shall be brought to the attention of the Building Official and the Registered Design Professional in Responsible Charge. The Special Inspection program does not relieve the Contractor of his or her responsibilities.

Inspections listed are periodic unless indicated to be continuous or required by code to be continuous.

Interim reports shall be submitted to the Building Official and the Registered Design Professional in Responsible Charge.

A *Final Report of Special Inspections* documenting completion of all required Special Inspections, testing and correction of any discrepancies noted in the inspections shall be submitted prior to issuance of a Certificate of Use and Occupancy.

Job site safety and means and methods of construction are solely the responsibility of the Contractor.

Interim Report Frequency: Weekly or ☐ per attached schedule.

Prepared by:

_____
(type or print name)

_____
Signature Date

Design Professional Seal

Owner's Authorization:

_____
Signature Date

Building Official's Acceptance:

_____
Signature Date

Schedule of Inspection and Testing Agencies

This Statement of Special Inspections / Quality Assurance Plan includes the following building systems:

- ☒ Soils and Foundations
- ☒ Cast-in-Place Concrete
- ☐ Precast Concrete
- ☒ Masonry
- ☒ Structural Steel
- ☐ Cold-Formed Steel Framing
- ☐ Spray Fire Resistant Material
- ☐ Wood Construction
- ☐ Exterior Insulation and Finish System
- ☐ Mechanical & Electrical Systems
- ☐ Architectural Systems
- ☐ Special Cases

Special Inspection Agencies	Firm	Address, Telephone, e-mail
1. **Special Inspector**		
2. Inspector		
3. Inspector		
4. Testing Agency		
5. Testing Agency		
6. Other		

Note: The inspectors and testing agencies shall be engaged by Owner or Owner's Agent, and not by Contractor or Subcontractor whose Work is to be inspected or tested. Conflicts of interest must be disclosed to the Building Official prior to commencing Work.

Qualifications of Inspectors and Testing Technicians

The qualifications of all personnel performing Special Inspections are subject to the approval of the Building Official. The credentials of all inspectors and testing technicians shall be provided if requested.

Key for Minimum Qualifications of Inspection Agents:

When Engineer deems it appropriate that the individual performing a stipulated test or inspection have a specific certification or license as indicated below, such designation shall appear below the *Agency Number* on the Schedule.

PE/SE	Structural Engineer – a licensed SE or PE specializing in the design of building structures
PE/GE	Geotechnical Engineer – a licensed PE specializing in soil mechanics and foundations
EIT	Engineer-In-Training – a graduate engineer who has passed the Fundamentals of Engineering examination

American Concrete Institute (ACI) Certification

ACI-CFTT	Concrete Field Testing Technician – Grade 1
ACI-CCI	Concrete Construction Inspector
ACI-LTT	Laboratory Testing Technician – Grade 1&2
ACI-STT	Strength Testing Technician

American Welding Society (AWS) Certification

AWS-CWI	Certified Welding Inspector
AWS/AISC-SSI	Certified Structural Steel Inspector

American Society of Non-Destructive Testing (ASNT) Certification

ASNT	Non-Destructive Testing Technician – Level II or III.

International Code Council (ICC) Certification

ICC-SMSI	Structural Masonry Special Inspector
ICC-SWSI	Structural Steel and Welding Special Inspector
ICC-SFSI	Spray-Applied Fireproofing Special Inspector
ICC-PCSI	Prestressed Concrete Special Inspector
ICC-RCSI	Reinforced Concrete Special Inspector

National Institute for Certification in Engineering Technologies (NICET)

NICET-CT	Concrete Technician – Levels I, II, III & IV
NICET-ST	Soils Technician - Levels I, II, III & IV
NICET-GET	Geotechnical Engineering Technician - Levels I, II, III & IV

Exterior Design Institute (EDI) Certification

EDI-EIFS	EIFS Third Party Inspector

Other

Soils and Foundations Page of

Item	Agency # (Qualif.)	Scope
1. Shallow Foundations		
2. Controlled Structural Fill		
3. Deep Foundations (Helical & Auger Cast Piles)		*Helical Piles and Augured Cast-In-Place Piles for Building and Stair Foundations load testing*
4. Load Testing		
4. Other:		

Item	Agency # (Qualif.)	Scope
1. Mix Design		*Concrete for Foundations (shear walls, grade beams, pile caps, etc.) and building slabs*
2. Material Certification		
3. Reinforcement Installation		*Reinforcement for foundations and building slabs*
4. Post-Tensioning Operations		
5. Welding of Reinforcing		
6. Anchor Rods		*Placement of cast-in-place anchors*
7. Concrete Placement		*Placement of slab, foundation and wall elements*
8. Sampling and Testing of Concrete		*Onsite samples for slab, foundation and wall elements*
9. Curing and Protection		*Curing/Protection for concrete slab, foundation and wall elements*
10. Other:		

Item	Agency # (Qualif.)	Scope
1. Plant Certification / Quality Control Procedures ☐ Fabricator Exempt		
2. Mix Design		
3. Material Certification		
4. Reinforcement Installation		
5. Prestress Operations		
6. Connections / Embedded Items		
7. Formwork Geometry		
8. Concrete Placement		
9. Sampling and Testing of Concrete		
10. Curing and Protection		
11. Erected Precast Elements		
12. Other:		

Masonry

Required Inspection Level: ☐

Item	Agency # (Qualif.)	Scope
1. Material Certification		*CMU wall material certification*
2. Mixing of Mortar and Grout		*Onsite Mixing of Mortar and Grout*
3. Installation of Masonry		*Installation of Masonry Units for Exterior and interior walls (Level B)*
4. Mortar Joints		*Placement of CMU mortar joints*
5. Reinforcement Installation		*Placement of vertical and horizontal reinforcement elements within the CMU wall*
6. Prestressed Masonry		
7. Grouting Operations		*Inspection of Grouting procedures for CMU installation*
7. Weather Protection		*Protection of Masonry wall construction during hot or cold weather installations*
9. Evaluation of Masonry Strength		*Laboratory testing of grout and mortar samples collected onsite.*
10. Anchors and Ties		*Installation of cast-in-place and post installed anchors to masonry.*
11. Other:		

Item	Agency # (Qualif.)	Scope
1. Fabricator Certification/ Quality Control Procedures ☐ Fabricator Exempt		*Certifications for welders and plant QC procedures*
2. Material Certification		*Certification of Structural steel materials to be in conformance with ASTM standards*
3. Open Web Steel Joists		
4. Bolting		*High Strength Bolting Installation for Bracing and Beam Connections*
5. Welding		*Shop review of plant performed welding and onsite welding performed*
6. Shear Connectors		*Installation of welded headed shear studs in concrete slab*
7. Structural Details		*Inspection of steel connection details in conformance with construction documents and approved shop drawings.*
8. Metal Deck		*Installation of metal and fastener requirements*
9. Other:		

Item	Agency # (Qualif.)	Scope
1. Member Sizes		
2. Material Thickness		
3. Material Properties		
4. Mechanical Connections		
5. Welding		
6. Framing Details		
7. Trusses Trusses		
8. Permanent Truss Bracing Permanent Truss Bracing		
9. Other:		

Item	Agency # (Qualif.)	Scope
1. Smoke Control		
2. Mechanical, HVAC & Piping		
3. Electrical System		
4. Other:		

Item	Agency # (Qualif.)	Scope
1. Wall Panels & Veneers		
2. Suspended Ceilings		
3. Access Floors		
4. Other:		

Item	Agency # (Qualif.)	Scope
1. Sprayed Fire-Resistive Materials: a. Physical and visual tests. b. Structural member surface conditions. c. Application. d. Thickness. e. Density. f. Bond Strength	 ASTM 605 ASTM 605 ASTM E736	*Spray fire resistive materials on structural steel* *Spec Section 07840*
2. Mastic and Intumescent Fire-Resistive Coatings	AWCI 12-B	*Intumescent coatings on structural steel* *Spec Section 07812*
3. Fire Resistant Penetrations	ASTM E2174	*Penetrations throughout.* *Spec Section 07843*
4. Fire Resistant Joints	ASTM E2393	*Joints in fire rated construction.* *Spec Section 07844*

Supplement B - Final Report of Special Inspections

Project:

Location:

Owner:

Owner's Address:

Architect of Record:

Structural Engineer of Record:

To the best of my information, knowledge and belief, the Special Inspections required for this project, and itemized in the *Statement of Special Inspections* submitted for permit, have been performed and all discovered discrepancies have been reported and resolved other than the following:

Comments:

(Attach continuation sheets if required to complete the description of corrections.)

Interim reports submitted prior to this final report form a basis for and are to be considered an integral part of this final report.

Respectfully submitted,
Special Inspector

(Type or print name)

Signature Date

Licensed Professional Seal

Agent's Final Report

Project:

Agent:

Special Inspector:

To the best of my information, knowledge and belief, the Special Inspections or testing required for this project, and designated for this Agent in the *Statement of Special Inspections* submitted for permit, have been performed and all discovered discrepancies have been reported and resolved other than the following:

Comments:

(Attach continuation sheets if required to complete the description of corrections.)

Interim reports submitted prior to this final report form a basis for and are to be considered an integral part of this final report.

Respectfully submitted,
Agent of the Special Inspector

(Type or print name)

Signature Date

Licensed Professional Seal or Certification

Supplement D - Fabricator's Certificate of Compliance

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per section 1704.2 of the International Building Code must submit a *Fabricator's Certificate of Compliance* at the completion of fabrication.

Project:

Fabricator's Name:

Address:

Certification or Approval Agency:

Certification Number:

Date of Last Audit or Approval:

Description of structural members and assemblies that have been fabricated:

I hereby certify that items described above were fabricated in strict accordance with the Contract Documents.

_____ _____

Signature Date

_____

Title

Attach copies of fabricator's certification or building code evaluation service report and fabricator's quality control manual.

+ + NO TEXT ON THIS PAGE + +

SECTION 01495

SPILL PREVENTION AND CONTROL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This section covers the Contractor's responsibilities with respect to spill prevention and control.

B. References: Where conflicts arise between requirements of the above-listed regulatory requirements, the most restrictive of the requirements shall be followed.
   1. USEPA Remedial Action at Waste Disposal sites EPA/625/6-B5/006
   2. 40 CFR Part 300 national Oil and Hazardous Substances Pollution Contingency Plan
   3. 40 CFR Protection of Environment
   4. ASTM E119 Fire Resistance Directory

1.2 SUBMITTALS

A. A Spill Prevention and Control Plan shall be provided to the Engineer.

1.3 GENERAL REQUIREMENTS

A. The Contractor shall prepare and implement a Spill Prevention and Control Plan and maintain appropriate containment and/or diversionary structures, materials and equipment to prevent and control the maximum spillage of any specific item within the Scope of Work. All materials and equipment used in connection with this project shall be included. The plan shall include inspection and test procedures performed to ensure compliance.

B. Laws and Regulations: The Contractor shall not pollute any area with any manmade or natural harmful materials. It is the sole responsibility of the Contractor to investigate and comply with all applicable Federal, State, County and municipal laws and regulations concerning the Spill Prevention and Control Plan.

C. A Project Telephone Directory shall be incorporated into the plan.

D. Written Discussions: In addition to the minimal prevention standards listed, the Plan shall include a complete discussion of conformance with the following applicable guidelines, other effective spill prevention and containment procedures, or if more stringent, with the State rules, regulations and guidelines.
   1. Facility Drainage

2. Bulk Storage
3. Facility Transfer operations, pumping, and conveying materials
4. Truck loading/unloading rack

E. Design and Specifications: The Contractor shall provide a Spill Prevention and Control Plan with the following designs and specifications:
   1. Appropriate containment and/or diversionary structures or equipment to prevent discharge of materials to the environment
   2. Dikes sufficiently impervious to contain spill materials
   3. Curbing
   4. Culverts, gutters, or other drainage systems
   5. Weirs, booms, or other barriers
   6. Sorbent materials
   7. Curbing drip pans
   8. Sumps and collection systems

F. Inspections and Records: Inspections required by this Scope of Work shall be in accordance with written procedures developed for the facility of the Contractor. These written procedures and a record of the inspections, signed by the appropriate supervisor or inspector, shall be part of the Spill Control and Prevention Plan, and shall be maintained during the project and submitted to the Engineer for final closeout.

G. Facility Lighting: Facility lighting shall be commensurate with the type and location of the facility. Consideration shall be given to the following:
   1. Discovery of spills, occurring during hours of darkness, both by operating personnel, if present, and by non-operating personnel (security personnel, the general public, local police, etc.)
   2. Prevention of spills occurring through acts of vandalism.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 GENERAL

A. If materials are released, the Contractor shall provide a written description of the event, corrective action taken, and plans for preventing a recurrence, as well as a written commitment of manpower, equipment, and materials required to expedite control and removal of any harmful quantity of materials released.

B. The Contractor shall notify the New York State Department of Environmental Conversation, Nassau County Department of Health, Nassau County Department of Public Works, and the Engineer within two hours of the release or spill.

3.2 TRAINING

A. Personnel Training and Spill Prevention Procedures: The Contractor shall be responsible for properly instructing his personnel regarding applicable pollution control laws, rules, and regulations; and in the operation and maintenance of equipment to prevent the discharge of materials.

B. Briefings: The Contractor shall schedule and conduct Spill Prevention Briefings for its operating personnel at intervals frequent enough to assure adequate understanding of the Spill Prevention and Control Plan for this project. Such briefings shall highlight and describe known spill events or failures, malfunctioning components, and recently developed precautionary measures.

C. Evacuation Routes shall be marked on the project site.

3.3 TESTING

A. Facility communication or alarm systems and spill control equipment must be tested and maintained by the Contractor as necessary to assure proper operation in time of emergency.

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SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. Temporary facilities and controls shall be provided in the manner designated hereinafter. These temporary facilities shall be provided at the South Shore WRF for this project.

B. Contractor shall coordinate and install all temporary facilities and controls in accordance with the requirements of the local authorities or utility companies having jurisdiction and in accordance with all state, federal and local codes, and regulations.

C. At the completion of the Work, or when the temporary facilities and controls are no longer required, subject to the approval of the County, the temporary facilities and controls shall be removed and the facilities restored to their original conditions by the Contractor.

D. Costs in connection with the temporary electric, lighting, heating and ventilation, and other miscellaneous temporary facilities and controls including but not limited to, installation, maintenance, relocation, and removal shall be borne by the Contractor.

1.2 TEMPORARY WATER FACILTIIES

A. The Contractor shall provide and pay all costs for all toilet facilities in sufficient numbers, for the Contractor's and Subcontractor' personnel on this Project.

B. Sanitary facilities shall be properly screened from public observation and shall be provided and maintained at suitable locations by the Contractor including Contractor's staging area, all as prescribed by the State Labor Regulations and local ordinances. This system shall not be connected to the local sanitary sewer system and the contents of same shall be removed periodically and disposed of in a satisfactory manner, as the occasion requires.

B. The Contractor is rigorously prohibit the nuisances within, on, or about the Work.

C. County Sanitary Facilities and Locker rooms are strictly prohibited from Contractors' and subcontractors' use.

D. County Sanitary Facilities and Locker rooms are prohibited from Contractor and subcontractors' use.

1.3 TEMPORARY SANITARY FACILITIES

A. The Contractor shall furnish and install a temporary electrical facilities system which shall consist of temporary electric service points, a temporary general lighting system, a security lighting system, a safety lighting system, and service to the Contractor's field offices.

B. The Contractor shall submit a drawing showing the proposed temporary electrical facilities system layout for approval by the Engineer prior to installation.
   1. Work Included: Temporary work shall include the following:
      a. Furnish and pay for all labor, material, and equipment for the installation of the temporary electrical facilities system. The installation shall comply with all applicable requirements of the National Electric Code and any other codes or bodies having jurisdiction.
      b. Furnish and pay for all labor material and equipment for the maintenance of the temporary electrical facilities system.
      c. Furnish and pay for labor, materials, and equipment for removing all temporary facilities.

C. Requirements:
   1. Temporary electrical facilities system shall be as herein specified and required for the contractor's use and shall be provided no later than thirty days after the date of Notice to Proceed.

D. Temporary Electric Service Points:
   1. The Contractor shall furnish, install, and maintain a temporary power distribution point local to the work area.
   2. At the temporary power distribution point, the Contractor shall furnish and install an overcurrent protection device. The overcurrent protection device shall be rated for 480 volts, three-phase, and shall be sized for Contractor's temporary electric requirements.
   3. The Contractor shall utilize an existing temporary service point located at USS-3 for serving the temporary electrical requirements. The Contractor shall modify the identified temporary distribution point as required to provide temporary electric service for the Work shown and specified. The Contractor shall provide a temporary transformer, a 100 Amp circuit breaker and any other equipment necessary and required to provide the temporary electric system with the specified capacity. The Contractor shall provide separate distribution circuit breakers or fused switches for disconnection and overcurrent protection of the temporary electrical facilities fed from the service point which shall include the Contractor's field offices and the security lighting system for the Staging Area.

4. The Contractor shall furnish and install circuit breakers or fused switches, transformers, wiring and conduit as required for the temporary power distribution point.
5. Distribution circuit breakers or fused switches shall be furnished and installed at each location for disconnection and overcurrent protection of the temporary electrical facilities, including the temporary general lighting system, the security lighting system, and the safety lighting system.
6. At the completion of the project, the Contractor shall remove the temporary electric service point facilities to the condition they were prior to construction.

E. Temporary General Lighting System:
1. The Contractor shall provide and maintain a temporary lighting system. The system shall conform to the applicable Federal and State codes, shall meet the illumination requirements specified herein, and shall meet the approval of the County.
2. Temporary general lighting system shall provide 120-volt receptacles and lighting for access to and egress from the work and for safe and expeditious construction within designated enclosed areas of the structure or structures.
3. Temporary general lighting system shall consist of wiring, switches, necessary insulated supports, poles, fixtures, receptacles, 100-watt lamps, guards, cutouts, and fuses as specified shown or required.
4. The Contractor shall furnish lamps, fuses, receptacles, and cords for the temporary general lighting system and shall replace broken and burned out lamps and blown fuses for the system.
5. Temporary general lighting system shall be installed progressively in the structure as the areas are enclosed or as lighting becomes necessary because of partial enclosure.
6. Required Illumination for Work Lighting:
   a. General: Five foot-candles.
   b. Stairs: Ten foot-candles.
   c. Construction Plant and Shops: Ten foot-candles.
   d. For Detail and Finishing Work: Twenty foot-candles.
   e. For Testing and Inspection: Thirty foot-candles.
   f. At First-aid Stations: Thirty foot-candles.
   g. Areas of OWNER'S Operations: One 300-watt lamp at intervals of 15 feet on centers.
7. The Contractor shall maintain the temporary general lighting system in safe
working order.
8. The Contractor shall arrange and install the lamps in a manner to provide an even distribution of illumination as necessary and required over the work areas.

9. If necessary and required, the Contractor shall install the receptacles in such a manner as to reach any point in the work areas with an extension cord not to exceed 40 feet in length.
10. In case of overloading of circuits, the County will restrict the use of tools as required for the correct loading.
11. The temporary general lighting system shall be used for small power purposes only.
12. Hand tools such as drills, hammers and grinders, may be connected to the temporary general lighting system provided that they are suitable for 120 volt, single phase, 60 hertz operation and do not have a power requirement exceeding 1,500 volt amperes. Only one unit may be connected to a single receptacle and shall not be connected to lighting outlets. Cords of tools shall not exceed 40 feet in length.
13. No Contractor will be permitted to proceed with any portion of his work which in the opinion of the Engineer, is not adequately illuminated. If any Work by any other Contractor requires special lighting other than what is provided, the Contractor shall arrange for same.
14. The Contractor shall keep the temporary general lighting system in service each working day, from Monday through Friday inclusive, by energizing the system at 7:00 A.M. and de energizing the system at 3:30 P.M.
15. Any Contractor requiring the use of a temporary general lighting system other than during the times set forth in the preceding paragraph from Monday through Friday, or at any time on Saturdays, Sundays or Holidays, shall pay the costs of energizing or de energizing the system and for keeping the system in operation.
16. Temporary general lighting system shall be removed in its entirety at the completion of the project.

F. Security Lighting System:
1. The Contractor shall furnish, install, and maintain a security lighting system to illuminate the Staging Area and the construction site outside the building.
2. Security lighting system shall consist of floodlights equal to Crouse Hinds Cat. No. MVD 4HCW O PC DF AF VS AF 400-watt mercury vapor lamp, Cat. No. ML2590 photocell, Cat No. ML5547 vandal shield and Cat. No. 105 N11 bracket for wood pole mounting. Floodlights shall be mounted approximately 30 feet above the ground.

3 Each floodlight shall be complete with a constant wattage, high power factor ballast in a cast aluminum housing, a flat clear lens of heat and impact resistant glass, photo control, lamp, and suitable mounting hardware.

4. Photometric performance shall be equal to that of the above specified unit with a beam spread of approximately 150 degrees horizontal to 80 degrees vertical and with a beam efficiency of not less than 55 percent,
5. Poles shall be 35-foot, class F wood and shall be securely set five feet in the ground.

6. Wiring for the security lighting system may be installed overhead. The security lighting system shall always be properly maintained and energized with each floodlight controlled by a photocell installed on the floodlight. The photocells shall be adjusted so that all floodlights are energized at approximately the same time, Broken, and burned out lamps shall be replaced.
7. Security lighting system shall be installed and made operative within 30 days after the date of the Notice to Proceed.
8. Security lighting system shall be removed in its entirety at the completion of the project,

G. Safety Lighting:

1, The Contractor shall provide, install, and maintain sufficient lighting fixtures to provide adequate light to ensure safe access to, egress from, and passage through the construction areas between the hours of 4:30 P.M. and 7:00

A.M. Monday through Friday and 24 hours per day for Saturdays, Sundays, and Holidays. The lighting system shall be operated by a time clock. Fixtures shall be 100 watt and shall be provided, as a minimum at every landing of every stairway and every 50 feet along passageways. The safety lighting system shall be installed progressively in structures as the designated areas are enclosed or as lighting becomes necessary because of partial enclosure. This lighting is not intended for construction purposes.

H. Contractors' Field Offices:

1. The Contractor shall extend the temporary electric service from the tie-in to the service point specified in Paragraph l.3.D.3 to the Contractor's field office within the Staging Area.
2. The Contractor shall be responsible for providing his own telephone facilities as required.
3. Electric service for connection to construction trailers is available from the Plant. The Contractor shall coordinate with the Plants for the power source (motor control center in local building) and shall install the electrical service as required to each Field Office.

I. Additional Facilities:

1. Should any portion of any Contractor's work require light or power in addition to that supplied by the temporary general lighting system herein described, they shall furnish, install and maintain such additional temporary lighting and power facilities at his own expense. Additional temporary lighting shall be sufficient for safe access to and egress from such work, and for safe expeditious construction.
2. The installation of additional facilities shall comply with all applicable requirements of the National Electric Code and any other codes of enforcing bodies having jurisdiction and shall be in-stalled so as not to interfere with the work of other Contractors.

3. Upon completion of the work under his contract, the Contractor responsible shall remove all additional facilities installed by him.

1.04 TEMPORARY HEATING FACILITIES

A. Temporary construction heating shall be provided by the Contractor responsible for the Work involved for all cold weather protection of his own equipment, Work, and his employee's comfort at all the times.

B. The Contractor shall provide all temporary building heat for heating the interior of all structures and building areas, which is necessary for the protection of all Work and equipment of the Contract for the comfort of his employees or his Subcontractor's employees, after the building or structure is temporarily enclosed. Hot water or steam from the existing plant system will not be available for use as temporary heating. The following requirements shall apply:
   1. All temporary heating methods proposed by Contractor shall be submitted to the County for approval and must comply with all federal, state and county rules and regulations.
   2. Temporary construction heat for "cold weather protection" shall be provided by Contractor responsible for the Work involved. "Cold weather protection" shall be considered to include both temporary heat and protective covers or enclosures required during the construction period prior to the enclosure of new buildings or buildings and structures being remodeled. "Cold weather protection" shall be provided until all construction requirements under the Contracts are complied with, or until the enclosure of a new building or structure complies with the requirements for temporary building heating as hereinafter specified in Paragraph 1.4.E.

C. The Contractor is to provide temporary heat for the temporary building heating system. The systems shall be gas or oil fired, steam, hot water, or warm air type. Electric heating will not be permitted.

D. No salamanders or other direct fired equipment will be allowed in areas of existing buildings, or in new construction areas where the use of such equipment will damage or deteriorate the construction or finishes or is harmful to employees working in the area.

E. Temporary building heating systems shall be complete, including pumps, radiators, unit heaters, water and heating piping, insulation, controls, or any other equipment necessary, all furnished and installed by Contractor. Systems shall include boilers, fuel, and fuel storage facilities or any other equipment necessary, all furnished and installed and paid for by the Contractor, including fuel and electrical costs. All fuel oil tanks shall be provided with adequate secondary containment and the fuel oil systems shall comply with Nassau County Fire Prevention Ordinance-Article III. Special notice is given to the Contractor that the electrical service and cost relative to obtaining temporary heating beyond those provided under the temporary electrical facilities shall be the responsibility of the Contractor and provided for

under temporary heating. This includes, but is not limited to, the cost of providing temporary light if it should be required.

F. A building, structure or gallery shall be considered to be temporarily enclosed when the area is covered by a permanent structural slab or deck and all openings through the permanent slab or deck are covered to prevent the entrance of rain or snow. Intermediate floor structures or multi floor buildings or structures shall be temporarily enclosed subject to the same requirements. The building shall be considered to be temporarily enclosed when one of the permanent exterior wall elements, concrete, block, or the permanent exterior wall, or facing material, is installed and all openings through that element are covered or temporarily enclosed to prevent the entrance of rain, snow, or direct wind. Openings through structures, intermediate floors or exterior wall elements shall be considered to be enclosed when that opening is covered with minimum ten mil plastic or minimum twelve (12) ounce waterproof duck canvas tarpaulins or with minimum three eighths inch thickness exterior grade plywood. Temporary covers or enclosures for openings shall be the responsibility of the Contractor.

G. Temporary building heating shall be provided from the first day of October to the last day of the following April. The system shall be capable of maintaining a minimum of fifty-five degrees Fahrenheit (55°F) simultaneously in all areas of construction in buildings, structures, or galleries. Temporary heating shall be provided on a twenty-four hours per day, seven days per week basis. Where it is determined by the County that higher temperatures are required in a particular area to protect installed equipment or new construction, it shall be so, provided under this Contract.

H. The Contractor shall provide and pay for all electric wiring and electrical accessories required for the temporary heating system.

I. Temporary heating equipment shall not be located to interfere with the new construction Work. Heating system equipment shall not cause undue noise or fumes and shall be enclosed by wire fencing, or other means to provide protection to personnel.

1.5 TEMPORARY VENTILATION FACILITIES

A. Temporary construction ventilation shall be provided by the Contractor for the protection of his equipment, Work and his employees' comfort and safety always.

B. The Contractor shall provide all temporary building ventilation for ventilating all structures and building areas, both above and below ground level, which is necessary for the protection of all Work and equipment of this Contract or for the comfort and safety of his employees, his Subcontractor's employees, or the employees of the other Contractors, after the building or structure is enclosed.

C. Ventilating systems may be forced or gravity type and shall be complete with fans, motors, inlets, outlets, ductwork, heaters, controls or any other equipment necessary, all furnished and installed by the Contractor responsible for the Work involved. The following additional requirements shall apply:
   1. All temporary ventilation methods proposed by the Contractor shall be submitted to the County for approval and must comply with all federal, state and county rules and regulations.
   2. Temporary ventilation shall be provided by the Contractor until the building or structure is enclosed.
   3. A building or structure shall be enclosed as hereinbefore specified in Paragraph 1.4, Temporary Heating Facilities.
   4. Ventilation air shall be heated to those temperatures specified for space or room temperatures as hereinbefore specified in Paragraph 1.4, Temporary Heating Facilities. Where dehumidification is required to prevent mildew or moisture forming on equipment, Work or structures in areas being ventilated, it shall be provided by the Contractor.

D. The Contractor shall provide and pay for all equipment and labor to operate the temporary ventilation system after a building or structure is enclosed. Heating required for the ventilation system shall be provided by the temporary heating system specified in Paragraph 1.4.

E. The Contractor shall provide and pay for all electric wiring and electrical accessories required for the temporary ventilation system.

F. Temporary ventilation equipment shall not be located to interfere with the operation of the new construction Work. Protective devices shall be provided for the protection of the personnel.

G. Temporary ventilation shall be supplied to all buildings or structures below grade at a minimum of three air changes per hour and the outside air shall be tempered to room temperature levels unless otherwise noted. Temporary ventilation shall be supplied to all new buildings or structures above grade only where required to protect equipment and Work being installed or for safety of employee.

1.6 PROTECTION OF WORK AND MATERIALS

A. Protection Requirements:
   1. During the progress of the Work and up to the date of Final Payment, the Contractor shall be solely responsible for the care and protection of all Work and materials covered by the Contract. To prevent damage, injury or loss, actions shall include, but not be limited to, the following:
      a. Store apparatus, materials, supplies, and equipment in an orderly, safe manner that will not unduly interfere with the progress of the Work or the work of any other contractor or utility service company.
      b. Provide suitable storage facilities for all materials, which are subject to injury by exposure to weather, theft, breakage, or otherwise.

c. Place upon the Work or any part thereof only such loads as are consistent with the safety of that portion of the Work.
d. Clean up frequently all refuse, rubbish, scrap materials, and debris caused by his operations, to the end that always the Site of the Work shall present a safe, orderly and workmanlike appearance.
e. Provide barricades and guard rails around openings, for scaffolding, for temporary stairs and ramps, around excavations, elevated walkways and other dangerous areas as deemed necessary by Engineer.

2. The Contractor shall protect the existing Work and material from damage by his workmen and shall be responsible for repairing any such damage at no additional cost to the County.
3. The Contractor shall protect trees, shrubbery and other natural features or structures from being cut, trimmed, or injured in his areas of Work. Trees adjacent to the Site of Work shall be protected and temporary supports provided for long branches. Stored materials and equipment shall be in cleared spaces, away from all trees and shrubs, and confined to areas as directed by the Engineer.
   a. Temporary fences or barricades shall be installed to protect trees and plants in areas subject to traffic.
   b. No fires will be permitted at the Bay Park STP.
   c. Within the limits of the Work, water trees and plants that are to remain, to maintain their health during construction operations.
   d. Cover all exposed roots with burlap that shall be kept continuously wet. Cover all exposed roots with earth as soon as possible. Protect root systems from mechanical damage and damage by erosion, flooding, run off or noxious materials in solution.
   e. If branches or trunks are damaged, prune branches immediately and protect the cut or damaged areas with emulsified asphalt compounded specifically for horticultural use in a manner approved by Engineer.
   f. All damaged trees and plants that die or suffer permanent injury shall be removed when ordered by the Engineer and replaced by a specimen of equal or better quality.
   g. Coordinate Work in this Section with requirements of Sections 02200, Earthwork, and 02485, Grassing and Planting.
4. All Work and materials shall be protected in accordance with the requirements of the Agreement, Article VI, "Protection"; General Conditions, Articles GC 17, "Materials and Equipment, Approvals Substitutions and Deviations", GC 21, "Protection Requirements", and GC 24, "Barricades, Warning Signs and Lights".

B. Maintenance of Egress:
1. During the course of demolition and construction Work of this Project, the Contractor shall maintain and keep free of debris, materials or equipment points of required egress in accordance with the requirements of the Nassau County Fire Commissioner and Fire Safety Regulations.
2. The Contractor in his area of Work shall maintain egress as herein specified.

3. In active process areas, the Contractor shall not be permitted to store or stockpile material. Debris or other material shall be removed daily which may obstruct plant personnel from operating or maintaining active equipment and piping.

C. Temporary Construction Fencing:
   1. The Work areas of the Project Site shall always be enclosed by temporary fencing to ensure security.
   2. Temporary fencing shall not be less than six feet in height. Fabric shall be ten-gauge minimum, electrically welded wire, forming a rectangular mesh with opening two by four inches and three rows of double barb ten-gage wire on angle brackets measuring two feet vertically. Fabric shall be mounted on heavy duty steel tee spaced at intervals not exceeding ten feet.
   3. The Contractor shall furnish, erect, relocate and maintain all temporary fencing. Upon completion of the Project all temporary fencing shall be removed and disposed of.
   4. All Work in connection with the temporary fencing shall be done at no additional cost to the County.

D. Protection of Existing Structures:
   1. Underground Structures:
      a. Underground structures are defined to include, but not be limited to, all sewer, water, gas, and other piping, and manholes, chambers, electrical and signal conduits, tunnels and other existing subsurface work located within or adjacent to the limits of the Work.
      b. All underground structures known to the Engineer, except water, sewer, electric and telephone service are shown on the Drawings. This information is shown for the assistance of the Contractor in accordance with the best information available but is not guaranteed to be correct or complete.
      c. The Contractor shall explore ahead of his trenching and excavation Work and shall uncover all obstructing underground structures sufficiently to determine their location, to prevent damage to them and to prevent interruption of the services which such structures provide. If the Contractor damages an underground structure, they shall restore it to original condition at his expense.
      d. Necessary changes in the location of the Work may be made by the Engineer, to avoid unanticipated underground structures.
      e. If permanent relocation of an underground structure or other subsurface facility is required and is not otherwise provided for in the Contract Documents, the Engineer will direct the Contractor in writing to perform the Work, which shall be paid for under the provisions of the Agreement.
   2. Surface Structures:
      a. Surface structures are defined as all existing buildings, structures, and other facilities above the ground surface. Included with such structures are their foundations or any extension below the surface. Surface

structures include, but are not limited to, buildings, tanks, walls, bridges, roads, dams, channels, open drainage, piping, piles, wires, posts, signs, markers, curbs, walks and all other facilities that are visible above the ground surface.

3. Protection of Underground and Surface Structures:
   a. The Contractor shall sustain in their places and protect from direct or indirect injury all underground and surface structures located within or adjacent to the limits of the Work. Such sustaining and supporting shall be done by the Contractor in a careful manner and as required by the County. Before proceeding with the Work of sustaining and supporting such structure, the Contractor shall satisfy the Engineer that the methods and procedures to be used have been approved by the County.
   b. The Contractor shall assume all risks attending the presence or proximity of all underground and surface structures within or adjacent to the limits to the Work. The Contractor shall be responsible for all damage and expense for direct or indirect injury caused by his Work to any structure. The Contractor shall repair immediately all damage caused by his Work to the satisfaction of the owner of the damaged structure.
4. All other existing surface facilities, including but not limited to guard rails, posts, guard cables, signs, poles, markers, and curbs, which are temporarily removed to facilitate installation of the Work shall be replaced and restored to their original condition at Contractor's expense.

E. Protection of Floors and Roofs:
   1. The Contractor shall protect floors, roofs and stairs from overloads, dirt, and damage during entire construction period. In areas subject to foot traffic, secure heavy paper, sheet goods, or other materials in place. For storage of products, lay tight wood sheathing in place. Cover walls and floors of elevator cars and surfaces of elevator car doors used by construction personnel.
   2. Proper protective covering shall be used when moving heavy equipment, when handling materials or other loads, when painting, when handling mortar and grout and when cleaning walls and ceilings.
   3. Use metal pans to collect all oil and cuttings from pipe, conduit, or rod threading machines and under all metal cutting machines.
   4. Concrete floors less than 28 days old shall not be loaded without written permission of the Engineer. No floor, roof or slab shall be loaded more than the design loading shown on the Drawings.
   5. Roof slabs shall not be loaded without written permission of the Engineer. Prohibit use of finished roofing surfaces for traffic of any kind, and for storage of any products. When activity must take place to carry out the Work, obtain recommendations of installer for protection of surface. Install recommended protection and remove on completion of that activity. Restrict use of adjacent unprotected areas.
   6. The Contractor shall restrict access to roofs and keep clear of existing roofs except as required by the new Work.

7. If access to roofs is required, roofing, parapets, openings, and all other construction on or adjacent to roof shall be protected with suitable plywood or other approved means.

F. Protection of Installed Products and Landscaping:
   1. Provide protection of installed products to prevent damage from subsequent operations. Remove protection facilities when no longer needed, prior to completion of Work.
   2. Control traffic to prevent damage to equipment, materials, and surfaces.
   3. Provide covering to protect equipment and materials from damage.
      a. Cover projections, wall corners, and jambs, sills, and soffits of openings, in areas used for traffic and for passage of products in subsequent Work.
   4. Prohibit traffic of any kind across planted lawn and landscaped areas.

G. Protection from Flood:
   1. The Contractor shall not allow any areas turned over to him for commencement of Work, to flood. The Contractor shall keep all existing and new facilities within his Work area free of any accumulations of water. The Contractor shall provide, install, and operate sufficient pumps for this purpose. Continuous monitoring for floods and protection of structures from damage and flotation shall be provided. The Contractor shall install any combination of suitable dikes, well points, pumps, and the like to protect the Work until it is accepted.

H. Special Protection of Machinery and Equipment:
   1. The Contractor shall take all protective measures to the satisfaction of the County necessary to ensure that inclement weather or dust and debris from demolition does not enter any of the mechanical or electrical equipment rooms or enclosures. Enclosures shall be provided where necessary to prevent contamination of the air. All protective measures shall be furnished, installed, lighted, ventilated, maintained, and removed at the Contractor's own cost.
   2. Interior dustproof covers shall be a heavy reinforced polyethylene film curtain, minimum thickness 6 mils, supported by wood framing. All seams and penetration shall be sealed with duct tape on two sides. Junctions with existing walls, floors and ceilings shall be made with a double fold secured with a backing strip anchored to the existing wall, floor, and ceiling.
   3. The Contractor shall be responsible for all damage to existing structures, equipment, and facilities caused by his construction operations and must repair all such damage when and as ordered at no additional cost to the County. All work shall be done in accordance with the requirements of Section 01039, Demolition and Removal of Existing Structures and Equipment.

I. Emergency Repair Crews
   1. In case the Contractor's operations disrupt plant operations, the treatment process or the operating facilities herein before described, at any time, they

shall at his own cost immediately make all repairs or replacements and do all work necessary to restore the plant to operation to the satisfaction of the County. Such work shall progress continuously to completion on a 24-hour/day, 7-workday/week basis. The Contractor shall provide the services of emergency repair crews, available on call 24 hours per day.

1.7 ACCESS ROADS, PARKING, STAGING, STORAGE AND WORK AREAS

A. Contractor's Staging and Storage Area
   1. The Contractor shall construct a Contractor's Staging Area as shown on the Contract Drawings. The Staging Area shall be leveled, graded, and seeded after completion of the Contract.
   2. The Staging Area shall be drained so that no ponding of runoff water shall occur in the Staging Area or adjacent areas.
   3. The Contractor shall erect six-foot high galvanized chain link fencing and gates around the Staging Area as specified in Paragraph 1.6.C.
   4. The Contractor shall provide pavement and utilities in the Staging Area and shall maintain all sections of the Staging Area in a suitable manner, including the cutting of grass, weeding, and preventing the accumulation of debris. The Contractor shall provide electrical utilities in the Staging Area.
   5. At the completion of the project, the Contractor shall remove all debris not limited to gravel, grout, wood, etc., from the Staging Area off-site. The Contractor shall also grade the Staging Area level and furnish a minimum of six (6) inches of topsoil, which will be unloaded, graded and hydro-seeded as directed by the Engineer.

B. Access Roads:
   1. Access roads will be provided by the Contractor in accordance with the requirements of the General Conditions, Article GC 22, "Access Roads and Parking Areas", the Drawings and the applicable Technical Specifications.
   2. The Contractor shall take all necessary precautions to protect traffic, including but not limited to, complying with the requirements of the General Conditions, Articles GC 23, "Traffic Regulations" and GC 24, "Barricades, Warning Signs and Lights".
   3. The Contractor shall always post speed limit signs to be adhered to in the vicinity of the staging and work areas.

C. Parking, Storage and Work Areas:
   1. No on-site parking is permitted.
   2. The Contractor shall construct and maintain suitable storage areas for his use within the staging area designated on the Drawings.
   3. The Contractor will be required to arrange his Work and dispose of his materials in such manner as to cause the least interference with the Work of other Contractors working within the same area.
   4. No Contractor shall claim exclusive occupancy of areas within or adjacent to the limits of his Work under this Contract. The County and its employees and the Contractors for other contracts shall also have access to these areas.

5. The Contractor shall modify any storage areas to cause minimum damage to the landscape and shall comply with the directions of the County. At the completion of the Work the surfaces of the land used for storage areas shall be restored by the Contractor to the satisfaction of the County and the Engineer.

1.8 CONTRACTOR'S FIELD OFFICE

A. The Contractor shall furnish, equip, and maintain a field office for his use at the Site during the period of construction. The Contractor shall provide his own telephone service and shall have readily accessible, at the field office, copies of the Contract Documents, latest approved Shop Drawings and all Project related correspondence, Change Orders, etc.

B. Contractor's field office shall be in the Staging Area.

C. The Contractor shall provide a Contractor's field office with the minimum facilities specified. Provide all required storage and work sheds.
   1. Field Office and Furnishings:
      a. Acceptable appearance, weatherproof building, or trailer with lockable door.
      b. Telephone service.
      c. Six protective helmets for visitor's use.
      d. Exterior identifying sign.
      e. Company sign no larger than four (4)-feet by eight (8)- feet.
   2. Remove office and sheds upon Final Acceptance unless otherwise approved by the Engineer.

1.9 SECURITY

A. It shall be the responsibility of the Contractor to make whatever provisions they deems necessary to safely guard all Work, materials, equipment and property from loss, theft, damage, and vandalism. The Contractor's duty to safely guard property shall include the County's property and other private property from injury or loss in connection with the performance of the Contract.

B. The Contractor may make no claim against the County for damage resulting from trespassing.

C. The Contractor shall repair all damage to the property of the County and others arising from failure to provide adequate security.

D. If existing fencing or barriers are breached or removed for purposes of obstruction, the Contractor shall provide and maintain temporary security fencing equal to the existing one, in a manner satisfactory to the Engineer and the County.

E. Security measures taken by the Contractor shall be at least equal to those usually provided by the County to protect his existing facilities during normal operation.

F. Maintain the security program throughout construction until the date of Substantial Completion and occupancy precludes need for Contractor's security program.

G. The Contractor's employees shall be issued identification badges, which shall always be displayed , as per Section 01356, Safe and Healthful Working Conditions, Paragraph 1.5.F.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

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SECTION 01516

TEMPORARY FIRE PROTECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. The Contractor shall provide temporary fire protection at the South Shore WRF Aeration Blower Facility Project for all areas where work under this contract is being performed and throughout the Project, until the Nassau County takes occupancy. Remove temporary fire protection when the Nassau County takes occupancy.
   2. The Contractor shall comply with Section 901.7 and 1404.5 of the Fire Code of New York State (2010).
   3. The Contractor shall pay all costs associated with temporary fire protection, including installation, maintenance, and removal.
   4. The Contractor shall conform to provisions of this Section and Laws and Regulations.

B. Reference Standards and Regulatory Requirements:
   1. Comply with applicable provisions of:
      a. NFPA Standard No. 10, Portable Fire Extinguishers.
      b. NFPA Standard No. 241, Safeguarding Building Construction and Demolition Operations.
      c. Fire Code of New York State, Section 901.7.
      d. Fire Code of New York State, Section 1404.5
   2. Temporary fire protection shall conform to Laws and Regulations.

1.2 REQUIRED TEMPORARY FIREFIGHTING EQUIPMENT

A. Provide portable fire extinguishers, rated not less than 2A or 5B in accordance with NFPA Standard No. 10 for each temporary building and for every 3,000 square feet of floor area under construction.

B. Provide portable fire extinguishers 50 feet maximum from all points in protected area.

1.3 FIRE PREVENTION AND SAFETY MEASURES

A. Prohibit smoking in hazardous areas and inside of the County's buildings. Provide visible, suitable warning signs in areas that are continuously or intermittently hazardous.

B. Storage of Flammable and Combustible Products:

1. Use metal safety containers for storing and handling flammable and combustible liquids and materials.
2. Do not store flammable or combustible liquids and materials in or near stairways or exits.

C. Maintain clear exits from all points at the Site.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01560

ENVIRONMENTAL CONTROLS

PART 1 – GENERAL

1.1 GENERAL

A. Provide and maintain methods, equipment, and temporary construction, as necessary to provide controls over environmental conditions at the construction site and adjacent areas. Remove physical evidence of temporary facilities at completion of Work.

1.2 NOISE CONTROL

A. Contractor's vehicles and equipment shall be such as to minimize noise to the greatest degree practicable. Noise levels shall conform to the latest OSHA standards and in no case will noise levels be permitted which interfere with the Work of the County or others.

1.3 DUST CONTROL

A. The Contractor shall be responsible for controlling objectionable dust caused by his operation of vehicles and equipment, clearing or for any reason whatever, in accordance with the General Conditions Article GC-25, "Dust Control and Spillage."

1.4 PEST AND RODENT CONTROL

A. Provide rodent and pest control as necessary to prevent infestation of construction or storage area.
   1. Employ methods and use materials, which will not adversely affect conditions at the Site or on adjoining properties.

B. Provide seals in accordance with the General Conditions, Article GC-26, "Vermin Control."

1.5 WATER CONTROL

A. Provide methods to control surface water and water from excavations and structures to prevent damage to the Work, the Site, or adjoining properties.
   1. Control fill, grading and ditching to direct water away from excavations, pits, tunnels and other construction areas; and to direct drainage to proper runoff courses so as to prevent any erosion, damage or nuisance.

B. Provide, operate and maintain equipment and facilities of adequate size to control surface water.

C. Dispose of drainage water in a manner to prevent flooding, erosion, or other damage to any portion of the Site or to adjoining areas and in conformance with all environmental requirements.

D. All work must conform to the Storm Water Pollution Plan.

1.6 POLLUTION CONTROL

A. Provide methods, means and facilities required to prevent contamination of soil, water or atmosphere by the discharge of noxious substances from construction operations.

B. Provide equipment and personnel, perform emergency measures required to contain any spillages, and to remove contaminated soils or liquids.
   1. Excavate and dispose of any contaminated earth off-site, and replace with suitable compacted fill and topsoil.

C. Take special measures to prevent harmful substances from entering public waters.
   1. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to streams, or in sanitary or storm sewers.

D. Provide systems for control of atmospheric pollutants.
   1. Prevent toxic concentrations of chemicals.
   2. Prevent harmful dispersal of pollutants into the atmosphere.

E. Contractor's equipment used during construction shall conform to all current federal, state and local laws and regulations.

1.7 EROSION CONTROL

A. Plan and execute construction work and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
   1. Hold the areas of bare soil exposed at one time to a minimum.
   2. Provide temporary control measures such as berms, dikes and drains.

B. Construct fills and waste areas by selective placement to eliminate surface silts or clays which will erode.

C. Periodically inspect earthwork to detect any evidence of the start of erosion, apply corrective measures as required to control erosion.

1.7 HAZARDOUS MATERIALS CONTROL

A. Refer to Section 01355, Hazardous Materials Control.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

+ + NO TEXT THIS PAGE + +

SECTION 01600

MATERIALS AND EQUIPMENT

PART 1 – GENERAL

1.1 GENERAL

A. Furnish and Install:
   1. Where the words "furnish", "provide", "supply", "replace" or "install" are used, whether singly or in combination, they shall mean to furnish and install, unless specifically stated otherwise.
   2. In the interest of brevity, the explicit direction "to furnish and install" has sometimes been omitted in specifying materials and/or equipment. Unless specifically noted otherwise, it shall be understood that all equipment and/or materials specified or shown on the Drawings shall be furnished and installed under the Contract as designated on the Drawings.

B. Concrete Work
   1. Contractor, unless specifically noted otherwise, shall provide all concrete shown, specified, or required under this Contract.

C. Concrete Maintenance Pads for Equipment:
   1. The Contractor shall provide all concrete maintenance pads shown, specified, or required within the building, for all equipment furnished under this Contracts.
   2. Anchor bolts and templates for equipment maintenance pads shall be furnished under the respective Contracts for installation by the Contractor. The General Construction Expansion, epoxy resin and grouted anchor bolts will be permitted unless shown or specified otherwise. The equipment manufacturer should show a normal equipment installation including the anchoring system in their shop drawing submittal. The anchoring system shall exhibit pertinent design criteria such as bolt diameter, embedment depth, pull out strength, spacing, type of anchor, edge distance, bolt patterns and certifications that the anchoring system will function properly with the equipment selected. The anchor system will be subject to additional requirements and testing called for in Section 05051 on these Contract Documents.
   3. All concrete maintenance pads for equipment shall be treated, by the Contractor, with a sealer, approved by the Engineer, to prevent oil from seeping into the concrete.

D. Contractor's Title to Materials:
   1. No materials or supplies for the Work shall be purchased by the Contractor or by any Subcontractor subject to any chattel mortgage or under a conditional sale contract or other agreement by which an interest is retained by the seller.

The Contractor warrants that they has good title to all materials and supplies used by him in the Work, free from all liens, claims or encumbrances.

E. "Buy American" Requirements of Financing Entity:
   1. The Project is financed by the New York State Environmental Facilities Corporation under the New York State Clean Water Revolving Fund. Contractor shall comply with requirements of the financing entity relative to the Project, including submitting all required documentation.
   2. Project financing is under the FY 2014 federal appropriations for the Clean Water State Revolving Fund (CWSRF). Comply with applicable requirements of the financing entity, including compliance with the FY 2014 CWSRF's "buy American" provisions.
   3. All the iron and steel products incorporated into the Work shall be produced in the United States, in accordance with the FY 2014 CWSRF provisions of H.R. 3547, "Consolidated Appropriations Act, 2014" (Appropriations Act), enacted on January 17, 2014.
   4. Under the Appropriations Act:
      a. "Iron and steel products" are defined as the following products made primarily of iron or steel: lined or unlined pipes and fittings, manhole covers and other municipal castings, hydrants, tanks, flanges, pipe clamps and restraints, valves, structural steel, reinforced precast concrete, and construction materials.
      b. The word, "steel" means an alloy that includes at least 50 percent iron, between 0.02 and two percent carbon, and may include other elements. Production in the United States of the iron or steel used in the Project requires that all manufacturing processes take place in the United States, except metallurgical processes involving refinement of steel additives. This requirement does not apply to iron or steel used as components or subcomponents of manufactured goods used in the Project.
      c. The words, "reasonably available quantity" mean that the quantity of iron, steel, or the relevant manufactured good is available or will be available at the time required on a schedule consistent with complying with the Contract Times and at the location place required, and in the proper form and quality as shown or indicated in the Contract Documents.
      d. The words, "satisfactory quality" mean the quality of iron, steel, or the relevant manufactured good as shown or indicated in the Contract Documents.
   5. Requirements for using United States iron and steel will not apply in any case or category of cases in which the Administrator of the U.S. Environmental Protection Agency (in this section referred to as the "Administrator") finds that:
      a. applying the "buy American" provision for iron and steel would be inconsistent with the public interest
      b. iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or

c. inclusion of iron and steel products produced in the United States will increase the cost of the Project by more than 25 percent.

6. Contractor shall submit information verifying compliance with the buy American requirements, certification of compliance with the buy American requirements, and when required information necessary to support applying for a waiver of the buy American requirements, as required by the Owner or the financing entity, under the provisions of the Appropriations Act and related guidance by authorities having jurisdiction over such funds and use thereof.

7. Contractor shall pay damages incurred by Owner for Contractor's failure to comply with provisions of the financing entity's requirements, including "buy American" provisions. Notwithstanding other provisions of the Contract Documents, failure to comply with the buy American requirements allows Owner to recover as special damages against Contractor, and Contractor shall pay, costs for all claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred by Owner resulting from such failure by Contractor, including without limitation impairment or loss of Project funding or financing, whether in whole or in part, from the financing entity, and damages incurred by Owner by Owner's obligations to the financing entity regarding Project funding or financing.

1.2 TRANSPORTATION AND HANDLING OF MATERIALS AND EQUIPMENT

A. The Contractor shall make all arrangements for transportation, delivery and handling of equipment and materials required for prosecution and completion of the Work in accordance with Section 01610, Transportation and Handling of Materials and Equipment.

1.3 STORAGE OF EQUIPMENT AND MATERIALS

A. The Contractor shall store his equipment and materials at the job Site in accordance with the requirements of the General Conditions, Article GC-17, "Materials and Equipment, Approvals Substitutions and Deviations", and as hereinafter specified. All equipment and materials shall be stored in accordance with manufacturer's recommendations and as directed by the Engineer, and in conformity to applicable statues, ordinances, regulations, and rulings of the public authority having jurisdiction.

B. The Contractor shall enforce the instructions of the County and the Engineer regarding the posting of regulatory signs for loading on structures, fire safety and smoking areas.

C. The Contractor shall not store materials or encroach upon private property without the written consent of the owners of such private property.

1.4 INSTALLATION OF EQUIPMENT

A. Equipment and materials shall be installed in accordance with the requirements of the General Conditions, Article GC-17, "Materials and Equipment, Approvals, Substitutions and Deviations".

B. Concrete maintenance pads for equipment shall be of approved design and shall be adequate in size, suitable for the equipment erected thereon, properly reinforced, and tied into floor slabs by means of reinforcing bars or dowels. Maintenance pads bolts of ample size and strength shall be provided and properly positioned by means of suitable templates and secured during placement of concrete. Maintenance pads shall be built, and bolts shall be installed in accordance with the manufacturer's approved shop drawings.

C. Before mounting equipment on a maintenance pad, the Contractor shall clean the top surface; if necessary, rough it with a star chisel and clean again; and clean out all maintenance pads bolt sleeves. The Contractor shall provide sufficient steel plate shims (about 2 inches wide and 4 inches long), and of a varying thickness (from 1/8 to 1/2 inch). A combination of these shims shall be placed next to each maintenance pads bolt to bring the bottom of the bedplate or frame about 1/8 inch above the final setting. The equipment shall be lowered by changing the combination of shims. Using brass shim stock of various thicknesses, continue to level the equipment a little at a time and in rotation until it is at the correct elevation in both directions. When the equipment is level, tighten down on the maintenance pads bolts a little at a time in rotation to make certain the equipment remains level and does not shift on the shims. A preliminary alignment check shall be made before grout is placed.

D. Equipment shall be set, aligned, and assembled in conformance with manufacturer's drawings or instructions. Runout tolerances by dial indicator method of alignment shall be plus or minus 0.002 inches, unless otherwise directed by the Engineer.

E. Blocking, wedges, shims, filling pieces, or other materials required by the proper support and leveling of equipment during installation shall be furnished by the Contractor. All temporary supports shall be removed, except steel wedges and shims, which may be left in place with the approval of the Engineer. Any grinding necessary to bring parts to proper bearing after erection shall be done at the expense of the Contractor.

F. Each piece of equipment or supporting base, bearing on concrete maintenance pads, shall be bedded in grout. The Contractor shall provide a minimum of 1-1/2-inch thick grouting under the entire baseplate supporting each pump, motor drive unit and other equipment. Mortar shall be non-shrink grout, as specified under Section 03600, Grouting.

G. When motors are shipped separately from driven equipment, the motors shall be received, stored, meggered once a month, and the reports submitted to the Engineer. After driven equipment is set, the motors shall be set, mounted, shimmed, millrighted, coupled and connected complete.
   1. Space heaters shall be supplied in all enclosures being utilized for storage of motors. All areas shall be heated.
   2. Electrical machines being stored shall be turned in accordance with the manufacturer's recommendations to prevent "flat-spotting" of bearings.

H. Anchor and expansion bolts will be furnished by the Contractor, as specified, and required. Expansion bolts shall only be used where permitted by the Engineer. Anchor and expansion bolts shall be of Type 304 stainless steel unless otherwise specified. Anchorage items shall conform to the applicable requirements of Section 05051, Anchor Systems.

I. Workmanship:
   1. The following erection Specifications are not intended to cover all instructions, but only some of the important practices. In all cases, only the best methods known to the trades are to be employed.
   2. Only those mechanics skilled in the handling, setting, alignment, leveling and adjustment of the type of equipment materials supplied shall be employed in the Work.
   3. An oil bath heater shall always be used to expand couplings, gears, etc. They shall not be forced or driven on equipment shafts, nor shall they be subjected to an open flame or torch.
   4. Wedging will not be permitted. Only the least number of flat shims are to be used in leveling equipment (shims are to be clean and free of slag). All shims, filling pieces, keys packing, red or white lead grout, or other materials necessary to properly align, level and secure apparatus in place shall be furnished by the Contractor. All parts intended to be plumb or level must be proven exactly so. Any grinding necessary to bring parts to proper bearing after erection shall be done at the expense of the Contractor.
   5. Proper tools shall be used in the assembly of equipment and materials to prevent marring the surface of shafts, nuts, and/or other parts.
   6. Connections requiring gaskets shall be tightened evenly all around to ensure uniform stress over the entire gasket area.
   7. No equipment and materials shall be altered or repaired, and no burning or welding will be permitted on any parts having machined surfaces, except by written permission of the Engineer.
   8. No rigging shall be done from any structure without the permission of the Engineer, and the Contractor shall be completely responsible for any damage to the structure due to his operations.
   9. Only such equipment and materials that will not damage the structure, equipment, or materials, shall be used on the Work.

10. The Contractor shall be responsible for the exact alignment of equipment with associated piping and, under no circumstances, will "pipe springing" be allowed.
11. Misaligned holes shall be reamed, as excessive driving of bolts or keys will not be permitted.
12. The Contractor shall furnish and install all necessary plugs in lubrication holes to prevent entry of foreign material.

J. Alignment and Leveling:
1. All couplings shall be aligned while the equipment is free from all external loads.
2. Both angular and parallel alignment shall be checked, and the degree of misalignment shall be recorded and submitted to the Engineer.
3. Dial indicators shall be used for the checking of angular and parallel alignment. During rotation of the half couplings in performance of this test, they shall be maintained in the same relative position, and the dial indicator readings shall be taken at the same place on the circumference of the coupling.
4. Misalignment shall not exceed the manufacturer's tolerances.

K. Threaded Connections:
1. A molybdenum disulfide anti-seize compound shall be applied to all threads in mechanical connections such as bolts, studs, cap screws, tubing, etc. unless otherwise indicated.

L. Lubrication:
1. All lubrication shall be performed by the Contractor before start-up, in accordance with the lubricant specifications and directions furnished by the manufacturer. The Contractor shall furnish the lubricants.

M. Electrical Connections:
1. Electrical connections shall be provided in accordance with the applicable requirements of Division 16, Electrical.

N. Painting:
1. All equipment and materials, unless specified otherwise, shall be field painted in accordance with the requirements of Section 09900, Painting.

O. Testing:
1. The Contractor shall carry out all checking and/or testing of installed equipment in accordance with manufacturer's specifications, and as required by the Engineer.

P. Maintenance of Installed Equipment:
1. During the time between installation and receipt of the certificate of completion, the Contractor shall maintain all equipment in accordance with

the equipment manufacturer's instructions and with the approval of the Engineer.

Q. Services of Manufacturer's Representatives:
   1. Equipment furnished under Divisions 2 through 16 shall include the cost of a representative of the manufacturers of all equipment as specified in the General Conditions, Article GC-17, "Materials and Equipment, Approvals, Substitutions and Deviations".
   2. Detailed Specifications contain additional requirements for furnishing the services of the manufacturer's representatives.
   3. A certificate from the manufacturer stating that the installation of the equipment is satisfactory, that the unit has been satisfactorily tested and is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication and care of the unit shall be submitted within thirty days of completion of the performance test.

1.5 CONNECTIONS TO EQUIPMENT

A. Connections to equipment shall follow manufacturer's recommendations as to size and arrangement of connections and/or as shown in detail on the Drawings or approved Shop Drawings. Piping connections shall be made to permit ready disconnection of equipment with minimum disturbance of adjoining piping and equipment. The Contractor shall be responsible for the exact alignment of equipment with associated piping and under no circumstances will pipe springing be allowed.

B. The Contractor shall be responsible for bringing proper electrical service to each item of equipment requiring electrical service as shown on the Drawings or approved Shop Drawings. Electrical connections to equipment requiring electrical service shall be made by the Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.

1.6 SUBSTITUTIONS

A. Requests for substitutions of equipment or materials shall conform to the requirements of the General Conditions, Article GC-17, "Materials and Equipment, Approvals, Substitutions and Deviations", and as hereinafter specified.
   1. The Contractor shall submit for each proposed substitution sufficient details, complete descriptive literature, and performance data together with Samples of the materials, where feasible, to enable the County to determine if the proposed substitution is equal.
   2. The Contractor shall submit certified tests, where applicable, by an independent laboratory attesting that the proposed substitution is equal.
   3. A list of installations where the proposed substitution is in satisfactory operation.

4. Requests for substitutions shall include full information concerning differences in cost, and any savings in cost resulting from such substitutions shall be passed on to the County.

B. Where the approval of a substitution requires revision or redesign of any part of the Work, all such revision and redesign, and all new Drawings and details required therefore, shall be provided by the Contractor at his own cost and expense, and shall be subject to the approval of the County.

C. In the event that the Engineer or his consultants is required to provide additional services, the charges for such additional services shall be charged to the Contractor by the County in accordance with the requirements of the General Conditions, Article GC-18, "Contractor Costs for Engineering Services".

D. Any modifications in Work required under other Contracts, to accommodate the changed design, will be incorporated in the appropriate Contracts and any resulting increases in Contract prices will be deducted by the County from payments otherwise due by the Contractor who initiated the changed design.

E. In all cases the County shall be the judge as to whether a proposed substitution is to be approved. The Contractor shall abide by their decision when proposed substitute items are judged to be unacceptable and shall in such instances furnish the item specified or indicated. No substitute items shall be used in the Work without written approval of the County.

F. In making request for substitution, the Contractor represents that:
   1. The Contractor has investigated proposed substitution, and determined that it is equal to or superior in all respects to the product, manufacturer or method specified.
   2. The Contractor has verified that proposed substitution will coordinate with existing design.
   3. The Contractor will provide the same or better warranties or bonds for proposed substitution as for product, manufacturer or method specified.
   4. The Contractor waives all claims for additional costs or extension of time related to proposed substitution that subsequently may become apparent.

G. Proposed substitutions will not be accepted if:
   1. Acceptance will require substantial revision of the Contract Documents.
   2. They will change design concepts or Specifications.
   3. They will delay completion of the Work, or the work of other contractors.
   4. They are indicated or implied on a Shop Drawing and are not accompanied by a formal request for substitution from the Contractor.

H. Approval of a substitution will not relieve the Contractor from the requirement for submission of Shop Drawings as set forth in the Contract Documents.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

+ + NO TEXT THIS PAGE + +

SECTION 01610

TRANSPORTATION AND HANDLING OF MATERIALS AND EQUIPMENT

PART 1 – GENERAL

1.1 GENERAL

A. The Contractor shall make all arrangements for transportation, delivery and handling of equipment and materials required for prosecution and completion of the Work.

B. Shipments of materials to the Contractor or Subcontractors shall be delivered to the Site only during regular working hours. Shipments shall be addressed and consigned to the proper party-giving name of the Project, street number and city. Shipments shall not be delivered to the County except where otherwise directed.

C. If necessary to move stored materials and equipment during construction, the Contractor shall move or cause to be moved materials and equipment without any additional compensation.

1.2 DELIVERY

A. Arrange deliveries of products in accordance with construction schedules and in ample time to facilitate inspection prior to installation.

B. Coordinate deliveries to avoid conflict with Work and conditions at site and to accommodate the following:
   1. Work of other contractors, or the County.
   2. Limitations of storage space.
   3. Availability of equipment and personnel for handling products.
   4. County's use of premises.

C. Do not have products delivered to the Project Site until related Shop Drawings have been approved by the Engineer.

D. Do not have products delivered to the Site until required storage facilities have been provided.

E. Have products delivered to the Site in manufacturer's original, unopened, labeled containers. Keep the Engineer informed of delivery of all equipment to be incorporated in the Work.

F. Partial deliveries of component parts of equipment shall be clearly marked to identify the equipment, to permit easy accumulation of parts and to facilitate assembly.

G. Immediately on delivery, inspect shipment to assure:
   1. Product complies with requirements of the Contract Documents and reviewed submittals.
   2. Quantities are correct.
   3. Containers and packages are intact, labels are legible.
   4. Products are properly protected and undamaged.

1.3 PRODUCT HANDLING

A. Provide equipment and personnel necessary to handle products by methods to prevent soiling or damage to products or packaging.

B. Provide additional protection during handling as necessary to prevent scraping, marring or otherwise damaging products or surrounding surfaces.

C. Handle products by methods to prevent bending or overstressing.

D. Lift heavy components only at designated lifting points.

E. Materials and equipment shall at all times be handled in a safe manner and as recommended by manufacturer or supplier so that no damage will occur to them. Do not drop, roll, or skid products off from delivery vehicles. Hand carry or use suitable materials handling equipment.

1.4 REMOVING, HAULING, AND INSTALLING EQUIPMENT AND MATERIALS

A. The Contractor shall inspect all items including all boxes, crates and packages containing equipment and materials for damage that may have occurred during shipment prior to its removal from the truck or other conveyance. Any damage shall immediately be reported to the Engineer. The Contractor shall then carefully remove the equipment and materials from the truck or trucks on which it is shipped. The equipment and materials shall then be transported to the place of installation at the job Site. The Contractor shall be liable for loss or damage that the equipment and materials may receive while being unloaded, transported, stored or installed. The Contractor shall employ competent mechanics experienced in the installation of the types of equipment and materials to be furnished, and shall ensure that all equipment and materials are installed in accordance with the recommendations of the manufacturer. Bolts, nuts and other fastenings shall be furnished by the Contractor, and shall comply with the applicable requirements as specified. Equipment that arrives at the job site during normal working hours shall be unloaded as soon as practicable.

1.5 COORDINATE STORAGE AND INSTALLATION

A. The Contractor shall coordinate storage and installation of new equipment with construction schedule for existing and new structures.

1.6 CONTRACTOR'S USE OF COUNTY LIFTING EQUIPMENT

A. The Contractor shall not be permitted to use any existing lifting equipment at County facilities unless the following procedure is followed:
   1. Contractor shall employ the services of a qualified representative of the lifting equipment manufacturer to inspect all equipment. The manufacturer shall certify that said equipment is in safe operating condition and meets the rated load capacities. The County makes no claim that any existing lifting equipment is in operable condition or meets the requirements of the Contractor. All costs for inspections, certifications and repairs shall be the responsibility of the Contractor.
   2. Upon submittal of the required certifications and receipt of written authorization from the County, the Contractor will assume full responsibility for the operation, maintenance and regular inspection of the lifting equipment for the duration of his work.
   3. Upon completion of his work, the Contractor shall employ the services of a qualified representative of the lifting equipment manufacturer to re-inspect the equipment. The manufacturer shall recertify that said equipment is in safe operating conditions. All costs for inspections, certifications and repairs shall be the responsibility of the Contractor.
   4. Upon submittal of the required certifications and acceptance by the County, the County will resume responsibility for the equipment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

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SECTION 01650

STARTING OF SYSTEMS

PART 1 – GENERAL

1.1 GENERAL

A. The Contractor shall initially start up and place all equipment installed by him into successful operation according to manufacturers' written instructions and as instructed by manufacturers' field representatives. Provide all material, labor, tools, equipment, and expendables required.

B. General Activities Include:
   1. Cleaning.
   2. Removing temporary protective coatings.
   3. Flushing and replacing greases and lubricants, where required by manufacturer.
   4. Lubrication.
   5. Check shaft and coupling alignments and reset where needed.
   6. Check and set motor, pump and other equipment rotation, safety interlocks, and belt tensions.
   7. Check and correct if necessary leveling plates, grout, bearing plates, anchor bolts, fasteners, and alignment of piping which may put stress on pumping equipment connected to it.
   8. All adjustments required.

C. Provide initial filling of lubricants and all other required operating fluids.

D. Also provide filters, chemicals, and other expendables required for initial startup of equipment unless otherwise specified.

1.2 MINIMUM START UP PROCEDURES

A. Bearings and Shafting:
   1. Inspect for cleanliness, clean, and remove foreign materials.
   2. Verify alignment.
   3. Replace defective bearings, and those which run rough or noisy.
   4. Lubricate as necessary, in accordance with manufacturer's recommendations.

B. Drives:
   1. Adjust tension in V belt drives and adjust varipitch sheaves and drives for proper equipment speed.
   2. Adjust drives for alignment of sheaves and V belts.
   3. Clean and remove foreign materials before starting operation.

C. Motors:
   1. Check each motor for comparison to amperage nameplate value.
   2. Correct conditions which produce excessive current flow, and which exist due to equipment malfunction.
   3. Check each motor for proper rotation.

D. Pumps:
   1. Check glands and seals for cleanliness and adjustment before running pump.
   2. Inspect shaft sleeves for scoring.
   3. Inspect mechanical faces, chambers, and seal rings, and replace if defective.
   4. Verify that piping system is free of dirt and scale before circulating liquid through the pump.

E. Valves:
   1. Inspect both hand and automatic control valves, clean bonnets, and stems.
   2. Tighten packing glands to assure no leakage, but permit valve stems to operate without galling.
   3. Replace packing in valves to retain maximum adjustment after system is judged complete.
   4. Replace packing on any valve which continues to leak.
   5. Remove and repair bonnets which leak.
   6. Coat packing gland threads and valve stems with a surface preparation of "Moly Cote" or "Fel Pro", after cleaning.

F. Verify that control valve seats are free from foreign material and are properly positioned for intended service.

G. Tighten all pipe joints after system has been tested.
   1. Replace gaskets which show any sign of leakage after tightening.

H. Inspect all joints for leakage.
   1. Promptly remake each joint which appears to be faulty, do not wait for rust to form.
   2. Clean threads on both parts, apply compound and remake joints.

I. After system has been tested, clean strainers, dirt pockets, orifices, valve seats and headers in fluid system, to assure freedom from foreign materials.

J. Open steam traps and air vents where used, remove operating elements.
   1. Clean thoroughly, replace internal parts and put back into operation.

K. Remove rust, scale and foreign materials from equipment and renew defaced surfaces.

L. Set and calibrate equipment.

M. Inspect fan wheels for clearance and balance. Provide factory authorized personnel for adjustment when needed.

N. Check each electrical control circuit to assure that operation complies with Specifications and requirements to provide desired performance.

O. Inspect each pressure gage and thermometer for calibration. Replace items which are defaced, broken, or which read incorrectly.

P. Repair damaged insulation.

Q. Vent gasses trapped in any part of systems. Verify that liquids are drained from all parts of gas or air systems.

1.3 INITIAL PLANT START UP

A. Prior to startup of the plant facilities, the Contractor shall have prepared and pre tested all equipment to check its ability for sustained operation, including inspections and adjustments by manufacturer's servicemen, as specified in Section 01660 and this Section. Also, all training by vendors shall have begun and all O&M manual submittals shall be completed prior to start-up.

B. After the facilities are sufficiently complete to permit start up, the Contractor shall furnish competent personnel to start up the plant facilities. The Contractor will be responsible for startup of all facilities constructed under this Contract. During the initial startup period the Contractor shall check and provide for satisfactory mechanical operation of the plant facilities. Prior to start up, the Contractor shall prepare a schedule detailing the proposed start up and his plans for manpower and auxiliary facilities to be provided. The startup schedule is subject to approval of the Engineer. Startup of the plant by the Contractor shall include the operation and maintenance of all mechanical facilities such as pumps, and like equipment, and the ventilating, air conditioning (or heating), and electrical systems. The start-up period shall be a minimum of ten (10) consecutive twenty-four (24)-hour days of satisfactory operation of the facility or the number of days called for in the Technical Specifications. Startup of either the heating or air conditioning systems is dependent upon the time of year that the plant start up is initiated. The Contractor will be required to return at the beginning of the next heating or air conditioning season (whichever is applicable) to start the appropriate system.

C. When the startup period is completed, the County will assume responsibility for operation of the new facilities, provided that all major items of the Work are operating satisfactorily and operation and maintenance training has been completed satisfactorily. If any or all of the new facilities are not operating satisfactorily at the end of the startup period, the Contractor shall continue to operate those facilities that are incomplete or not operating satisfactorily until they are complete and acceptable to the County.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 01660

QUALITY CONTROL

PART 1 – GENERAL

1.1 GENERAL

A. All materials and equipment will be tested and inspected to insure full and complete compliance with the Specifications as determined by the County. All testing shall be in accordance with the American Society for Testing Materials and other Specifications as specified herein. Responsibility for performing testing shall be in accordance with the Detailed Specifications.

B. The County will perform the tests tabulated in the General Conditions, Article GC 19, "Inspection and Testing".

C. The Contractor shall perform all other testing laboratory services and furnish all test reports in accordance with the requirements of the General Conditions, Article GC 19, "Inspection and Testing".

D. The Contractor shall perform all leak testing of concrete structures as described herein.

1.2 FIELD TESTING OF EQUIPMENT

A. General:
   1. Field testing of equipment shall conform to the requirements of the General Conditions, Article GC 19, "Inspection and Testing", the Technical Specifications and as hereinafter specified.

B. Preliminary Field Tests, Yellow Tag:
   1. As soon as conditions permit, after the equipment has been secured in its permanent position, the Contractor shall check the equipment for alignment, direction of rotation and absence of defects.
   2. Purpose of tests is to determine if equipment:
      a. Is properly installed.
      b. Complies with operating cycles.
      c. Is operational and free from overheating, overloading, vibration, or other operating problems.
   3. The Contractor shall flush all bearings, gear housings, etc., in accordance with the manufacturer's recommendations, to remove any foreign matter accumulated during shipment, storage or erection. Lubricants shall be added as required by the manufacturer's instructions.
   4. The Contractor shall furnish all labor, materials, instruments, fuel, incidentals, and expendables required, unless otherwise provided.

5. The Contractor shall make all changes, adjustments and replacements required to place equipment in service and test it.
6. The Engineer and the County shall be given sufficient prior notice to witness tests.
7. When the Contractor has demonstrated to the Engineer that the equipment is ready for operation, a yellow tag will be issued. The tag will be signed by the Engineer or his designated representative, and attached to the equipment. The tag shall not be removed.
8. Preliminary field tests, yellow tag, must be completed before equipment is subjected to final field tests, blue tag.

C. Final Field Tests, Blue Tag:
1. Upon completion of the installation, and at a time approved by the Engineer, equipment will be tested by operating it as a unit with all related piping, ductwork, electrical controls and mechanical operations.
2. To the maximum extent possible, the Contractor shall perform final field tests of equipment prior to initial startup and operation of the Project. Where this is not practicable, final field tests shall be performed during initial startup and operation of the Project.
3. Purpose of the tests is to demonstrate that equipment is:
   a. Properly installed.
   b. Completely ready for operation by the County personnel.
   c. In compliance with design conditions, material specifications and all other requirements of the Contract Documents.
4. The Contractor shall submit the test procedure for approval by the Engineer. The procedure shall specify the duration and the parameters of the test.
5. The Contractor shall notify the Engineer at least twenty-four (24) hours prior to beginning of tests. The Contractor shall keep notes and data on tests and submit copy to the Engineer. The Engineer and the County's operating personnel shall witness all tests.
6. The equipment will be placed in continuous operation as prescribed or required and witnessed by the Engineer or his designated representative.
7. Each pump shall be tested at maximum rated speed for the number of points specified in the Technical Specifications, but no less than four points, on the pump curve for capacity, head and electric power input. The rated motor nameplate current and power shall not be exceeded at any point within the specified range. Vibrometer readings shall be taken when directed by the Engineer and the results recorded.
8. Pumps with drive motors rated at less than five horsepower shall only be tested for excess current or power when overheating or other malfunction becomes evident in general testing.
9. Until final field tests are acceptable to the Engineer, the Contractor shall make all necessary changes, readjustments and replacements at no additional cost to the County.
10. Defects which cannot be corrected by installation adjustments will be sufficient grounds for rejection of any equipment.

11. Upon acceptance of the field tests a blue tag will be issued. The tag will be signed by the Engineer and attached to the unit. The tag shall not be removed, and no further construction Work will be performed on the unit, except as required during startup operations and directed by the Engineer.
12. All costs in connection with such tests including all materials, equipment, instruments, labor, etc. shall be borne by the Contractor.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

+ + NO TEXT THIS PAGE + +

SECTION 01700

MAINTENANCE OF PLANT OPERATIONS

PART 1 – GENERAL

1.1 GENERAL

A. The intent of this Section is to have Contractor perform his Work in such a manner that continuous, uninterrupted treatment of the waste flows (air and water) and all essential Plant services and facilities are maintained operational throughout the construction period.

B. Except for the scheduled shutdowns specified in this Section and in other Contracts, the existing plant will be maintained in continuous operation by the County during the entire construction period under all Contracts. Work under this Contract shall be so scheduled and conducted by Contractor such that it will not impede any treatment process, create potential hazards to operating equipment and Plant Personnel, reduce the quality of the plant effluent or cause odor or other nuisance. In performing the Work shown and specified, Contractor shall plan and schedule Work to meet both constraints outlined in this Section and plant operating requirements.

C. The work covered in the following paragraphs may not be all inclusive of all work which may affect plant operations. All operations which involve the demolitions, isolation or tie into existing plant equipment and/or systems will be submitted for approval.

D. Temporary pumping or fluming will be required during this project for the maintenance of plant drainage systems which are to be rerouted.

E. Contractor has the option of providing additional temporary facilities that can eliminate a constraint, provided it is done without additional cost to the County, and provided that it does not require any other Contractor to perform additional work, and provided that all requirements of these Specifications are fulfilled.

F. The Contractor shall not shut off or disconnect any operating system of the Plant. All Plant equipment operation and equipment shutdowns shall be executed by the County. The Contractor shall put in place a Lock Out Tag Out (LOTO) system for the safety of their workers in conjunction with Plant's LOTO.

G. The Contractor should be aware that existing valves, dampers, sluice gates, and other shutoff devices may not be tight closing and that supplemental pumping and/or other means may have to be provided by the Contractor to isolate the system as intended.

H. This Section of the Specifications contains several references to equipment, piping, material and appurtenances to be removed or reinstalled. The Contractor shall also refer to the Drawings and other applicable Sections for definition of the equipment, piping, material and appurtenances to be removed and turned over to the County and stored on site, or to become the property of the Contractor and removed from the site.

I. Related Sections:
   1. Section 01031, Additions, Modifications and Alterations to Existing Buildings and Structures.docx
   2. Section 01500, Temporary Facilities and Controls.
   3. Section 02050, Demolition, Removals and Modifications.

1.2 GENERAL CONSTRAINTS

A. Paragraph 1.5 of this Section specifies the sequence and shutdown duration (where applicable) for Plant units which are to be taken out of service. The operational status of new or existing "units", "utility systems", etc., other than the designated "units", "utility systems", etc., shall not be interrupted by the Contractor during the specified time periods. New "units", "utility systems", etc., may only be used after the specified testing and acceptance of the "units", "utility systems", etc.

B. The following constraints shall be applied to all equipment and appurtenant utility systems on the Plant site.
   1. Load limits on Access Roads: Existing and new underground facilities such as electrical duct banks, pipelines, etc., in, under and crossing plant roads have been designed for a maximum wheel load of AASHTO H-20. The Contractor shall not exceed this weight limit.
   2. Access to Plant Site: An unobstructed traffic route through all Plant gates must be maintained at all times.
   3. Internal Roads Access: Vehicular access to all treatment units and buildings must always be maintained.
   4. Personnel Access: Treatment Plant Personnel must have access to all areas that remain in operation throughout the construction period.
   5. Potable Water System: The existing potable water system shall be kept in operation at all times.
   6. Plumbing Facilities: Sanitary facilities in the existing structures shall be operational at all times for Plant operating personnel. All other building plumbing systems such as roof and floor drains, pumping, etc. shall be maintained for all structures.
   7. Storm Drainage: Storm drainage on the site shall be operational at all times.
   8. Building Heating and Ventilating: In the Contractor's work areas and areas affected by the Contractor's operations, building heating and ventilating shall be both provided and maintained by the Contractor. Temperatures to be maintained in any area occupied by Plant Personnel such as offices, lunchrooms, locker rooms, toilet rooms, etc., shall be at least 65 °F. Temperatures to be maintained in all other interior Plant areas, whether new,

existing or temporary, shall be maintained at a minimum of 55°F as specified in Section 01500, Temporary Facilities and Controls.

9. Power, Light and Communication Systems: Electric power, lighting service and communication systems shall be maintained in uninterrupted operation in all areas unless otherwise shown or specified.
10. Draining Process Pipes and Conduits:
    a. Unless otherwise specified, the contents of pipes and conduits undergoing modifications shall be transferred to the Plant drain sewer system using hoses, piping, or pumps (if hydraulic conditions so require them) by the Contractor whose Work requires the draining.
    b. If a drain is not available on the pipe to be drained, then a wet tap shall be made by the Contractor using an approved tapping saddle and valve. No uncontrolled spillage of a pipe's contents shall be allowed.
    c. All spillage shall be immediately washed down by the Contractor to the floor drains, sumps and sump pump discharge piping flushed out by the Contractor to prevent clogging and septic odors.
11. Dead End Valves or Pipe: The Contractor shall provide blind flanges on all valves or pipe that dead-end a line on a temporary or permanent basis as specified in Section 02050, Demolition, Removals and Modifications.

1.3 SHUTDOWNS

A. General:
1. Shutdown shall be defined to indicate that a portion of the normal operation of a Plant unit has to be suspended or taken out of service in order to perform the specified work. For each shutdown, the Contractor shall compile an inventory of its labor and materials required to perform the tasks, an estimate of the time required, and a written description of steps required to complete the tasks. Contingency time shall be provided where existing shut-off devices do not close tight and supplemental pumping and/or other devices are required to maintain dry conditions. The inventory, the estimate and written procedure shall be submitted to the County for review 60 calendar days prior to the proposed start date of the shutdown. The Contractor shall also request in writing, from the County, approval for each shutdown a minimum of fourteen calendar days prior to the proposed date. No shutdown shall be initiated until the list of materials and labor is verified on site at least one week prior to the proposed start date.
2. Work required which will interrupt the normal Plant operations shall be accomplished at such times that will be convenient to the County.
3. The Contractor shall provide 7-day advance notice of needed shutdowns to all Plant and Operations staff.
4. The Contractor shall also have on hand, located in close proximity to the Work area, all tools, equipment and materials, both temporary and permanent, necessary to complete each work category, without interruption. Adequate numbers of personnel shall be scheduled for each shutdown, so that the work may be accomplished within the specified time frame. Prefabrication of all piping, ductwork and other assemblies shall be completed to greatest degree

possible, prior to any shutdowns. The County shall be satisfied that the Contractor has complied with these requirements, to the fullest extent possible, before shutdowns will be authorized.

B. Shutdowns of Mechanical and Electrical Systems: The Contractor and the County shall each lock out and tag circuit breakers and switches operated by the County, and shall check cables and wires to be sure that they are de-energized to ground potential before Work begins and that all mechanical isolation devices are functional. Upon completion of the Work, the Contractor shall remove the locks and tags and advise the County that the facilities are available for use. The County will then remove their locks and place facilities back into use.

1.4 OVERTIME

A. Overtime Work by the Contractor necessary to conform to the requirements of this Section and related Sections shall be performed by the Contractor and the Contractor shall make no claims for extra compensation as a result thereof.

1.5 MAINTENANCE OF PLANT OPERATIONS (MOPO) AND SEQUENCE OF CONSTRUCTION

A. In order to maintain a continuous plant operation during construction, a MOPO Description Section is included after this Section. The category order and item order within each category are not intended as an exact sequence of work or a listing of priorities. However, within each item procedural steps, time constraints and milestone dates may be outlined and are intended to recommend a sequence and timing in order to maintain the continuous operation of the Plant.

B. The Contractor shall note that all necessary shutdowns may not be included in the MOPO Descriptions. As the need for additional shutdowns becomes evident, the Contractor shall notify the Engineer, who with assistance and approval of the County, will arrange for necessary shutdowns.

C. Contractor is advised that work in multiple areas of the Plant performed simultaneously may be required in order to complete the entire scope of the Contract within the allotted time.

D. Refer to "Detailed MOPO Descriptions", located after "End of Section" designation.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01700A

DETAILED MAINTENANCE OF PLANT OPERATIONS (MOPO) DESCRIPTIONS

Index to MOPO Items

Item No.:	Description:	Page:
1	Existing utility relocations and demolition	01700A-2
2	Build the new blower building, establish all plumbing, HVAC, electrical and I&C connections	01700A-2
3	Install process aeration blower(s) and complete all testing and commissioning of the blowers	01700A-2
4	Install header piping on top of aeration tanks (ATs)	01700A-2
5	Clean tank and construction new baffle wall and aeration header drop-legs into AT-1, and transition from existing to new process air blower system	01700A-2
6	Clean tank and construction new baffle wall and aeration header drop-legs into AT-2, and transition from existing to new process air blower system	01700A-2
7	Clean tank and construction new baffle wall and aeration header drop-legs into AT-3, and transition from existing to new process air blower system	01700A-3
8	Clean tank and construction new baffle wall and aeration header drop-legs into AT-4, and transition from existing to new process air blower system	01700A-3
9	Clean tank and construction new baffle wall and aeration header drop-legs into AT-5, and transition from existing to new process air blower system	01700A-3
10	Disconnect existing 42-inch process air header from WYE wall connection points	01700A-3

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MAINTENANCE OF PLANT OPERATIONS

Item Number:	Item Description:	Time Constraints:	Phasing Requirements:	General definition of Work to be performed:
1	Existing utility relocations and demolition	None	Must be completed before Item No. 2 commences	Relocate and demolish existing utilities at location of new aeration blower building
2	Build New Blower Building, install new aeration blowers and ancillary equipment, establish all plumbing, HVAC, electrical and I&C connections	None	Must be completed before Item No.: 5 thru 10	Construct new building superstructure including all site improvements and building utility connections
3	Complete aeration blowers installation and complete all testing and commissioning of the blowers and process control system.	None	Must be completed before Item No.:5 thru 10 Requires Item No.: 2 to be substantially complete before Item No. 3 can commence.	Furnish, install and test new aeration blower equipment and I&C
4	Install Header piping on top of each aeration tanks	None	Must be completed before Item No.: 5 thru 10 Can occur concurrently with Item No. 2 and Item No. 3.	Construct new aeration header piping, including structural supports above aeration tanks.
5	Clean tank and construction new baffle wall and aeration header drop-legs into AT-1, and transition from existing to new process air blower system	Sixty (60) days + four (4) weeks to demonstrate new equipment operations and achieve process stability*	Must be started after Item No.: 2 thru 4	Clean AT-1, install final aeration drops from new header, construct baffle wall and start-up and commission tank
6	Clean tank and construction new baffle wall and aeration header drop-legs into AT-2, and transition from existing to new process air blower system	Sixty (60) days + four (4) weeks to demonstrate new equipment operations and achieve process stability*	Must be started after Item No.: 2	Clean AT-2, install final aeration drops from new header, construct baffle wall and start-up and commission tank

7	Clean tank and construction new baffle wall and aeration header drop-legs into AT-3, and transition from existing to new process air blower system	Sixty (60) days + four (4) weeks to demonstrate new equipment operations and achieve process stability*	Must be completed after Item No.: 6	Clean AT-3, install final aeration drops from new header, construct baffle wall and start-up and commission tank
8	Clean tank and construction new baffle wall and aeration header drop-legs into AT-4, and transition from existing to new process air blower system	Sixty (60) days + four (4) weeks to demonstrate new equipment operations and achieve process stability*	Must be completed after Item No.: 7	Clean AT-4, install final aeration drops from new header, construct baffle wall and start-up and commission tank
9	Clean tank and construction new baffle wall and aeration header drop-legs into AT-5, and transition from existing to new process air blower system	Sixty (60) days + four (4) weeks to demonstrate new equipment operations and achieve process stability*	Must be completed after Item No.: 8	Clean AT-5, install final aeration drops from new header, construct baffle wall and start-up and commission tank
10	Demolition of WYE wall aeration piping	None	Must be completed after Item No.: 9. May be started in an single aeration tank after that aeration tank is converted over to the new aeration system and process stability is achieved and accepted by the County.	Demo existing aeration header piping as depicted on plans

*Restriction for work associated with the AT tank improvements contingent upon satisfactory equipment demonstration, which will be determined at the time of test period.

GENERAL NOTE: The existing aeration treatment process must remain fully operational during construction. Any construction/demolition that effects the existing aeration treatment process must be coordinated and reviewed, and a construction sequencing plan to maintain the existing operations must be submitted in writing to the Owner's operator/Engineer within ninety (90) consecutive calendar days (CCDs) from the Notice to Proceed in accordance with the Coordination Drawings requirement stipulated in Article GC14 – Contractor Submissions section of the General Conditions. The following sequences may not be all encompassing, and the Contractor is required to review the sequences prior to bid and shall make no claims thereafter regarding the requirements set forth.

SEQUENCE OF CONSTRUCTION:

Item 1: Existing utility relocations and demolition

1. Contractor shall demo and relocate existing utilities in vicinity of new process aeration blower building prior to commencing construction of new process aeration blower building.
2. Contractor to prepare dewatering plan and support of excavation plans and for review and comment before obtaining dewatering permit or scheduling utility removal excavation
3. Secondary Bypass channel to be removed ahead of tank drain removal and relocation. Coordinate preliminary settling effluent & secondary settling tank effluent flow bulkheading with plant operation.
4. Relocate 16" FTE and remove 6" EW, 6" SLW and 2" SA before relocating 24" tank drain line.
5. 24" Tank drain relocation to be completed before existing section of existing 24" tank drain line and manhole is removed.
6. Contractor to provide temporary storm drain piping and system to allow for removal of storm drain piping in area of new aeration bldg. and installation of new storm drain piping and inlet after aeration bldg. foundation work is completed.
7. Other miscellaneous utility demolition and relocation work in the project aera to be performed as needed and as impacted with the other utility demolition and relocation work.

Item 2: Build New Blower Building, install new aeration blowers and ancillary equipment, establish all plumbing, HVAC, electrical and I&C connections.

1. Contractor shall construct the new aeration blower building structure, including site improvements and utility installations and connections.
2. Commission all electrical, plumbing and HVAC building appurtenances before commencing with the commissioning of the process aeration blower equipment and I&C

Item 3: Complete aeration blowers installation and complete all testing and commissioning of the aeration blowers and process control system.

1. Contractor shall complete installation, test and commission all process aeration blower equipment and I&C systems/devices.
2. Contractor may activate first new aeration blower for testing and commissioning at a time while existing blowers are still in operation.
3. As new aeration blowers are activated and put into service for the converted aeration tanks 1-5, a maximum of 5 blowers combined, including existing blowers and new blowers, may be in operation at any one time.

Item 4: Install Header piping on top of each aeration tanks.

1. Contractor shall construct new header piping including structural supports located above the aeration tanks, all instrumentation and monitoring equipment, and connect the new header piping to the aeration blower discharge piping location at the new aeration building.
2. Construct new above tank manifold piping to each aeration tank (i.e. AT-1, AT-2, AT-3, AT-4 and AT-5).

Items 5 thru 9: Clean tanks and construction new baffle wall and aeration header drop-legs into AT-1 thru 5 as noted in MOPO schedule requirement above, and transition from existing to new process air blower system.

1. Contractor shall coordinate with facility operations and maintenance personnel (i.e. Veolia) to take Aeration Tank (AT) offline and completely empty the contents of the tank after it is taken offline. Operator will drain AT to approximately 1 foot of AT mixed liquor depth. Contractor shall clean remaining mixed liquor and debris from the tank.
2. After AT is taken offline and drained by facility operations and maintenance personnel, the Contractor shall remove tank covers and clean the interior surfaces of the tank using high-pressure water and dispose of the residual materials generated from the cleaning operations. Contractor shall protect all tank drains from deleterious materials via use of removable screening devices to be provided under contractor submitted and approved means and methods. Introduction of chemical cleaning agents is prohibited. Remove grit material from bottom of tank before commencing with high-pressure water cleaning operations to prevent grit from entering tank drains.
3. After the interior surfaces of AT are cleaned, contractor shall demo existing aeration drop leg connections from WYE wall piping and install new drop leg aeration piping connections to existing diffuser grids and install new baffle wall(s), and demo existing aeration piping not scheduled for reuse within the existing AT wye wall as depicted on plans. Seal any hydraulic gates found to be leaking.
4. Contractor shall be prepared to allow plant operations to redirect preliminary effluent flow into offline tanks under high flow conditions, if necessary. Contractor will be given 24 hours' notice to have all uninstalled materials and equipment removed from the AT before the sewage is directed into the tank. AT will be drained by plant operations after high flow conditions subside, and Contractor will clean tank and equipment inside the tank again as needed to facilitate continuing the work. Recleaning of each of the 5 full aeration tanks one (1) time due to allowing sewage into the tank for a high flow condition during the conversion work is to be included in the Lump Sum bid, equating to a total of 5 full aeration tank recleanings over the course of all the aeration tank conversion work. (Note: One full aeration tank is comprised of 4 tank passes). Any materials or equipment left in the AT by the Contractor that is damaged, or no longer usable for the proposed contract work will be replaced by the Contractor at no additional cost to the Owner.

5. Contractor shall coordinate with the County operations team to schedule the disconnection of 1 of the 2 aeration grid drops in each aeration tank pass during the conversion work so that existing aeration system can feed air to the tank if needed during a high flow storm event and that the period of time that no air can be provided to the aeration tank during the conversion work before start up is the shortest period possible.
6. Upon completion of new work in AT, coordinate with facility operation and maintenance personnel to re-fill tank with process water, reseed, and begin the four-week demonstration, start up and process stabilization period by aerating AT using the new aeration blower building.
7. Contractor shall allow up to 4 weeks for process restarting and stabilization after each aeration tank is placed back into service, before another aeration tank may be taken offline for conversion. County operations will be sole judge of process stabilization acceptance.

Item 10: Demolition of WYE wall aeration piping

1. Contractor shall demo existing WYE wall process air piping per the extents depicted on the plans.

++ END OF SECTION 01700A ++

SECTION 01710

CLEANING

PART 1 – GENERAL

1.1 GENERAL

A. Execute cleaning, during progress of the Work, at completion of the Work, and as required by the General Conditions, Article GC-33, "Cleaning".

B. Requirements of Regulatory Agencies:
   1. In addition to the requirements herein, maintain the cleanliness of the Work and surrounding premises within the Work limits so as to comply with federal, state, and local fire and safety laws, ordinances, codes and regulations.
   2. Comply with all federal, state and local anti-pollution laws, ordinances, codes and regulations when disposing of waste materials, debris and rubbish.

C. Scheduling of Cleaning and Disposal Operations:
   1. So that dust, wash water or other contaminants generated during such operations do not damage or mar painted or finished surfaces.
   2. To prevent accumulation of dust, dirt, debris, rubbish and waste materials on or within the Work or on the premises surrounding the Work.

D. Waste Disposal:
   1. Dispose of all waste materials, surplus materials, debris and rubbish off the plant Site.
   2. Do not burn or bury rubbish and waste materials on the plant Site.
   3. Do not dispose of volatile or hazardous wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
   4. Do not discharge wastes into streams or waterways.

E. Cleaning Materials:
   1. Use only cleaning materials recommended by manufacturer of surface to be cleaned.
   2. Use each type of cleaning material on only those surfaces recommended by the cleaning material manufacturer.
   3. Use only materials which will not create hazards to health or property.

F. During Construction:
   1. Keep the Work and surrounding premises within work limits free of accumulations of dirt, dust, waste materials, debris and rubbish, in accordance with the General Conditions, Article GC-33, "Cleaning."
   2. Keep dust generating areas wetted down.
   3. Provide suitable containers for storage of waste materials, debris and rubbish until time of disposal.

4. Dispose of waste, debris and rubbish off Site at legal disposal areas.

G. When Project is Completed:
   1. The Contractor shall clean and maintain the Site in accordance with Division 1, Section 01760, Project Closeout.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 – GENERAL

1.1 GENERAL

A. The Contractor shall maintain and provide the Engineer with Project record documents as specified below except where otherwise specified or modified in the Specifications or in the General Conditions, Article GC-5, "Drawings and Specifications" and Article GC-36, "Record Drawings."

1.2 MAINTENANCE OF DOCUMENTS

A. Maintain the Contractor's field office in clean, dry, legible condition, complete sets of the following: Contract Drawings, Specifications, Addenda, approved Shop Drawings, Samples, photographs, Change Orders, other Modifications of Contract, test records, survey data, Field Orders, and all other documents pertinent to Contractor's Work.

B. Provide files and racks for proper storage and easy access. File in accordance with the filing format of the Construction Specification Institute (CSI) unless otherwise approved by the Engineer.
   1. Make documents available at all times for inspection by the Engineer and the County representative.
   2. Record documents shall not be used for any other purpose and shall not be removed from the office without the Engineer's approval.

1.3 RECORDING UPDATED INFORMATION

A. General:
   1. Label each document "PROJECT RECORD" in 2-inch high printed letters.
   2. Keep record documents current, and updated at least monthly.
   3. Do not permanently conceal any Work until required information has been recorded.

B. Contract Drawings: Legibly mark to record actual construction including:
   1. Depths of various elements of foundation in relation to datum.
   2. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
   3. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.
   4. Field changes of dimensions and details.
   5. Changes made by Change Order or Field Order.
   6. Details, not on original Contract Drawings.

C. Specifications and Addenda: Legibly mark up each Section to record:

1. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
2. Changes made by Change Order or Field Order.
3. Other matters, not originally specified.

D. Shop Drawings: Maintain as record documents and legibly annotate Drawings to record changes made after review.

1.4 FINAL SUBMISSION OF RECORD DOCUMENTS

A. Record Drawings:
1. . At the completion of the Work, Contractor shall furnish to the Engineer record drawings one (1) reproducible (Mylar) media set and on CD-R one (1) electronic bound AutoCAD drawing set in Release 2013 or later and one (1) compiled PDF set showing the actual in-place installation of these items installed under this Contract. The AutoCAD drawings shall conform to the Bay Park Program and specific contract CAD Plans. Drawings shall show the Work in plan and sections as required for clarity with reference dimensions and elevations for complete Record Drawings. Documentation shall be furnished not later than thirty (30) days after the completion of the Work and prior to Final Payment.
2. At the completion of all electrical Work under this Contract, the Contractor shall furnish to the Engineer, reproducible Mylar tracings showing a one-line diagram of the distribution system and the actual in-place grounding system, lighting arrangement , motor control centers, equipment and conduit and cable plans. Tracing shall be furnished not later than thirty (30) days after the completion of the Work and prior to Final payment

3. The Contract Drawings may be used as a starting point in developing these Drawings. The Subcontractor and manufacturer's drawings may be included in this package. The drawing package must be fully integrated and include the necessary cross-references between Drawings. The drawing package shall include interconnection and termination details to the equipment furnished un this Contract.

4. All Drawings must be submitted for approval of the Engineer. This shall include the following composite drawings for the system being furnished:

   a. Schematic (Elementary) Diagrams: This shall include but not be limited to complete schematics including items furnished by others for the following:
      1) Motor control circuits for starters furnished under this Contract.
      2) Substation controls.
   b. Wiring (connection) diagrams: These shall be included for all pre-wired equipment furnished under this Contract.
   c. Interconnection diagrams: These shall include all interconnections to be furnished under this Contract.
   d. Conduit and cable schedules: These shall include all conduit and cable furnished under this Contract.

e. Dimension of outline drawings: These shall include all equipment furnished under this Contract.
f. Power and lighting layout drawings: These shall include all conduits and wiring furnished under this Contract.

B. Submittal:
1. At completion of Project, deliver record documents to the Engineer.
2. Accompany submittal with transmittal letter containing:
a. Date.
b. Project title and number.
c. Contractor's name and address.
d. Title and number of each record document.
e. Certification that each document as submitted is complete and accurate.
f. Signature of the Contractor, or his authorized representative.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

NO TEXT ON THIS PAGE

SECTION 01730

OPERATION AND MAINTENANCE DATA

PART 1 – GENERAL

1.01 GENERAL

A. Provide operation and maintenance data in the form of instructional manuals for use by the County's personnel for:
   1. All equipment and systems.
   2. All valves, gates and related accessories.
   3. All instruments and control devices.
   4. All electrical gear.

1.02 LUBRICATION SURVEY

A. Provide a lubrication survey, made by a lubricant supply firm, subject to the approval of the Engineer, and paid for by the Contractor.

B. Lubrication survey shall list all equipment, the equipment manufacturer's lubrication recommendations, and an interchangeable lubricants tabulation standardizing and consolidating lubricants whenever possible. Include lubricant type, quantities and frequencies for each piece of equipment.

C. The Contractor shall supply all lubricants, applicators and labor for lubricating the equipment, in accordance with manufacturer's recommendations, for field-testing and prior to final acceptance. A supply of required lubricants sufficient for start-up and one year of operation shall also be supplied by the Contractor.

D. Twelve copies of the approved lubrication survey shall be furnished prior to final acceptance.

1.03 SPARE PARTS AND SPECIAL TOOLS

A. Spare Parts:
   1. As soon as practicable after approval of the list of equipment, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and source or sources of supply. This information shall also be included in the Operations and Maintenance Manuals.
   2. The Contractor shall also furnish a list of parts, and supplies that are either normally furnished at no extra cost with the purchase of the equipment, or specified to be furnished as part of the Contract and a list of additional items recommended by the

manufacturer to assure efficient operation for the particular installation for a period of one year or the guarantee period, whichever is greater.

3. All parts shall be securely boxed and tagged, and clearly marked on the box and individually for identification as to the name of manufacturer or supplier, applicable equipment, part number, description and location in the equipment. All parts shall be protected and packaged for a shelf life of at least ten years.

B. Special Tools:
   1. The Contractor shall furnish at no additional cost to the County with each piece of equipment as a minimum, two complete sets, or the number of sets called for in the Technical Specifications, of suitably marked special tools and appliances which may be needed to adjust, operate, maintain, or repair the equipment.
   2. The Contractor shall submit, for approval by the Engineer, a complete list of the special tools and appliances to be furnished. Such tools and appliances shall be furnished in approved painted steel cases properly labeled and equipped with good grade cylinder locks and duplicate keys.

1.04 OPERATION AND MAINTENANCE MANUALS

A. Final Operations and Maintenance Manuals:
   1. As a prerequisite to obtaining payments for equipment furnished under this Contract in excess of fifty percent of the Contract amount, the Contractor shall prepare, submit and obtain the Engineer's approval of an operation and maintenance manual for each item of equipment supplied under this Contract. Each item of equipment shall be identified with the equipment identification number given in the Contract Documents or as furnished by the Engineer. Each manual shall be prepared specially for this installation and shall include all approved Shop Drawings, all pertinent and legible instructions, technical bulletins and other printed matter required to provide fully accurate and comprehensive information for the safe and proper operation, maintenance and repair of the equipment item. It shall include, but not be limited to the following:
      a. Catalogs, diagrams, schematics, drawings, instructional bulletins and manuals marked by underlining, checking, the use of arrows or the obliteration or removal of extraneous data, so as to pertain only to the specific equipment item for which the manual is supplied. Original reprints of manufacturers' catalog information and maintenance data shall be furnished; photocopies or facsimile (FAX) copies will not be acceptable.
      b. Complete electrical schematics and wiring diagrams. Complete wiring between terminal points must be shown. Computerized diagrams are not acceptable.
      c. Drawings, diagrams and illustrations shall be original quality and clearly legible. Facsimile copies are not acceptable. Reduced drawings shall not be reduced to less than one-half of the original size. All lines, dimensions, lettering and text must be clearly legible.
      d. Reference to features and elements of equipment, such as operational limits of time, speed, pressure, temperature, etc., shall be clear, complete and

compatible with authoritative published engineering reference documents. Torque ratings shall be given for all bolted connections. All functional components, electrical systems, equipment, etc., shall be shown on diagrams and discussed in the text so as to identify their proper system relationship. Operation, service, trouble-shooting, checkout and in-line and bench repair procedures, identifying specific system characteristics of the equipment, shall be provided. Detailed start-up and shutdown procedures shall be included as a separate section for each piece of equipment or system.

e. Recommended procedures and frequencies for preventive maintenance such as inspection, adjustment, lubrication, calibration and cleaning shall be provided including pre-startup checklists for each piece of equipment and long-term shutdown maintenance.

f. Equipment parts shall be identified by manufacturer's part number and located with relation to other components of the equipment utilizing "exploded" type drawings for clarity. Complete parts lists shall be included, which indicate the part number, the part description, applicable serial and model numbers, current unit prices and the name, address and telephone number of the nearest equipment manufacturer's representative and nearest service and spare parts warehouse. Complete instructions for the ordering of all replaceable parts shall be noted in this section of the Manual. Recommendations as to spare parts and spares inventory levels shall be made. Lead time and shelf life values and preservation, packaging and labeling methods shall be recommended.

g. All copyrighted material used in the manual or in any operation required in the performance of the Contract will be preceded by the Contractor obtaining the copyright holder's written permission to use such material. The Contractor shall hold the County and the Engineer free of any legal responsibility for its use.

2. Each operation and maintenance manual shall be bound in a durable, permanent, stiff cover binder of one (more if required) volume with a complete index of the manual's contents arranged by subject matter and in order of presentation in each volume. Applicable equipment item numbers, as shown in the Contract Documents, shall be prominently included at their appropriate location in the index. The title of the manual shall be securely affixed to the binder in two places: the front cover and the binder back edge. The title shall identify the Project by number and name, state the volume is an O&M manual, generally classify the equipment and state the manufacturer's name, equipment model number and equipment identification number.

   a. Covers shall permit easy removal of pages and shall be of the three-post, metal-hinged, self-expanding type and shall not be overfilled. Covers shall be oil, moisture and wear resistant and approximately 9 by 12 inches in size.

   b. Page size shall be 8-1/2 by 11 inches; paper shall be 60 pound and holes reinforced with plastic cloth or metal.

   c. Drawings, diagrams and illustrations shall be attached foldouts up to 11 by 17 inches in size; larger sizes shall be inserted in the attached clear plastic envelopes marked as to contents.

3. Contractor's submittal to the Engineer for approval shall consist of three complete sets of each operation and maintenance manual and two copies of an itemized listing providing cross-reference identification between the Specification Sections of the Contract Documents, the approved Shop Drawings, and the operations and maintenance manual submittal. One copy of the manual and itemized listing will be returned to the Contractor stamped either "Approved" or "Disapproved", the latter when the Manual submittal is considered inadequate, inaccurate or lacking essential information. Discrepancies will be noted on the return itemized listing of a "Disapproved" submittal. The Contractor shall rectify all unapproved submittals by replacing submitted portions or adding additional data, as required, to the manual. The manual's index of contents and the itemized, cross-referenced listing shall be revised to reflect all revisions or additions made. Then two copies of the entire package shall be resubmitted to the Engineer for approval.
4. Upon approval of the operation and maintenance manuals, the Contractor shall submit ten copies of the manual and the itemized listing to the County.

1.05 MAINTENANCE AND LUBRICATION SCHEDULES

A. For all items of equipment furnished, Contractor shall provide a list including the equipment name, and address and telephone number of the manufacturer's representative and service company so that service and/or spare parts can be readily obtained. In addition, a maintenance and lubrication schedule for each piece of equipment shall be submitted with the Shop Drawings. Submission shall be in fifteen copies. The schedules shall be in the form indicated below.

Sample Maintenance Schedule

Sample Maintenance Schedule			
Item	**Action**	**Frequency**	**Remarks**

Sample Lubrication Schedule				
Item	**Manufacturer's Recommendations**	**Type Lubricant**	**Quantity Per Tank**	**Frequency**

1.06 EQUIPMENT START-UP SERVICES

A. Equipment start-up period, shall begin after satisfactory completion and acceptance of the field tests described in Section 01660, Quality Control, and shall end before the certified date of substantial completion for the part of the Work for which the equipment is included. If the equipment is not covered by a certificate of substantial completion for a part of the Work, the period shall begin upon substantial completion of the Project.

B. During the equipment start-up period the Contractor shall furnish, at no additional cost to the County, the services of factory-trained representatives of the equipment manufacturers for the equipment designated in the Specifications to:
   1. Assist in the start-up and operations of the equipment.
   2. Conduct training of plant personnel in the proper operation and maintenance of the equipment.

C. The County shall:
   1. Provide the necessary plant personnel for training in the operation and maintenance of the equipment during their regularly assigned work shifts.

D. The Contractor shall pay for all chemicals consumed up to the date of "certified substantial completion", and in addition shall provide the quantities of fuel and chemicals specified in Section 01660, Quality Control.

E. The Contractor shall be available to promptly repair all Work during the start-up period so as to cause minimum disruption to the total plant operation.

F. Upon completion of a minimum of ten consecutive twenty-four hour days of satisfactory operation, or the number of days called for in the Technical Specifications, the County will assume operation and operating cost of the equipment. If the equipment malfunctions during this start- up period, the start-up period will be repeated until satisfactory operation is achieved.

G. In the event a system, equipment or component proves defective or is unable to meet specified performance criteria, the Contractor shall replace the defective item, and the minimum two years guarantee period, or the guarantee period called for in the Technical Specifications for the item, shall start after satisfactory replacement and testing of the item.

1.07 TRAINING

A. As part of these services, the Owner will provide the necessary plant personnel for training in the operation and maintenance of the equipment. The Owner's personnel shall operate all equipment. The number of personnel to be trained, the class size and number of days the training shall be given shall be as indicated in the respective equipment specifications. Where the number of personnel and/or class size is not indicated in the respective equipment specifications, the Contractor shall assume a class size of 20 personnel.

B. The training shall consist of both classroom and field instruction. The purpose of field instruction shall be to reinforce topics covered in the classroom and to identify the location of any valves, pushbuttons, control panels switches, and other equipment required for operation; and to identify the location of any maintenance equipment such as grease fittings, oilers, isolation valves, safety lockout switches, and other equipment.

C. All training, unless otherwise specified, shall take place at the work site at a place specified by the Owner and shall be conducted by qualified training specialists.

D. Separate training sessions shall be conducted for the Owner's mechanical operations and maintenance personnel and for the Owner's electronic and electrical maintenance personnel.

E. The Contractor shall coordinate the manufacturers training services with the Owner and the Engineer, providing a minimum of fourteen (14) days prior notice of training, subject to the approval of the Engineer and the Owner.

F. In order to provide training for an adequate number of the Owner's operation and maintenance personnel, all training sessions shall be provided twice and shall be scheduled by the Owner to accommodate their shift schedule. All training shall be conducted during the hours of 8:00 AM to 12 AM until conclusion of the training course.

G. The Contractor shall deliver all training material to the Engineer and the Owner a minimum of fourteen (14) days prior to the scheduled training.

1.08 POWER POINT PRESENTATION

A. The Contractor shall provide a Power Point Presentation for each plant training session.

B. The manufacturer shall have the right of ownership of one copy of the power point presentation utilized for training.

C. The contractor must submit, for approval by the Engineer and the Owner, a power point presentation (s) covering the equipment supplied. Include the presentation in CD disk form for content review as part of the submittal package. Approval of such power point(s) shall be contingent upon their content meeting the lesson plan requirement of this Section. When the power point presentation (s) are approved by the Engineer and the Owner, the Owner shall have the right to permanent ownership and use of at least one complete copy.

D. The power point presentation must include a section identifying the Complete System Overview including all related and associated equipment specific to that particular system and how the specific piece of equipment operates within that system.

E. The Power Point Presentation must be Site Specific covering all related system items being presented in the training session. Handouts should mirror this presentation to include and be specific to the entire presentation.

1.09 LESSON PLANS

A. The Contractor shall submit the equipment manufacturer's lesson plans which shall include specific information about each item of equipment or equipment system, including controls. Lesson plans shall include but not be limited to the following information and meet the following requirements.

1. The Contractor shall submit the equipment manufacturer's lesson plans for approval by the Engineer no less than sixty (60) days prior to the date that the training is to take place.
2. Lesson plans shall indicate the estimated duration of each segment of the training and the training audience that the instruction is to address. The training audience refers to the Owner's mechanical operation and maintenance personnel and the Owner's electronic/electrical maintenance personnel, as appropriate.
3. The lesson plan shall indicate when training aids are used or referred to during the course of instruction.
4. An outline of required lesson plan contents is included below:

B. Equipment Description:

1. Purpose and function of equipment and auxiliary equipment and systems.
2. Physical arrangement of equipment components and electrical supply.
3. General function of controls, including automatic and manual operation, interlocks, and shutdowns.

C. Equipment Operation:

1. Operating requirement for equipment to perform satisfactorily.
2. Typical operating characteristics.
3. Start-up and shutdown procedures.
4. Use of controls.

D. Equipment Monitoring:

1. Recommended routine instrument readings and operational checking.
2. Early warning signs of developing operational or equipment problems.
3. Procedures for handling non-routine problems such as alarms, power failures, component failures, etc.

E. Equipment operational troubleshooting procedures.

F. Safety and Housekeeping:

1. Safety features of the equipment.
2. Safe practices.

3. Housekeeping practices.

G. Description of the use of the equipment manufacturer's O&M Manual as regards operation.

H. Preventive Maintenance Requirements:

1. Maintenance needs for equipment.
2. Identification of procedure to satisfy maintenance need (relate to equipment manufacturer's O&M Manual, which should have detailed descriptions of maintenance procedures).
3. Outline or summarize procedures.
4. Recommended schedule for performing preventive maintenance.
5. Provide preventive maintenance record forms (if available).

I. Maintenance Inspection Program:

1. Parts, components and areas of equipment to inspect for routine preventive maintenance.
2. Recommended frequency of inspection.
3. Inspection procedures.
4. Problem identification.

J. Maintenance Troubleshooting:

1. Sections in O&M Manual detailing troubleshooting procedures.
2. Summarize troubleshooting procedures.
3. Testing equipment used in troubleshooting.
   a. Demonstration of use of specialized testing equipment if supplied with equipment.
   b. Other testing equipment.
4. Tests used to verify troubleshooting findings.

K. Disassembly and Assembly:

1. Summarize disassembly and assembly procedures.
2. O&M Manual coverage of subject.
3. Testing to verify success of corrective maintenance.

L. Equipment Calibration:

1. Calibration needs and tolerances.
2. Calibration equipment.
3. O&M Manual listing of calibration ranges, tolerances and settings.

1.10 TRAINING AIDS

A. Training aids shall be used as an integral part of the training program. Training aids shall include PowerPoint presentations, as per Paragraph 1.10.B, and pictorial handouts specific to the equipment supplied. Handouts shall be legible and printed on good quality stock. Handouts shall be submitted when lesson plans are submitted.

B. Additional training aids shall be used for maximum training effectiveness and shall include the following as appropriate:

1. Audio visual aids, for example, PowerPoint presentations, films, videotapes, slides, overhead transparencies, posters, blueprints, diagrams, and catalogue cuts.

2. Models and samples, for example, cutaways, spare parts, tools, miniature models, equipment assemblies, and damaged parts.

C. The use of additional training aids shall be identified in the lesson plan, and a description of the additional training aids shall be given.

1.11 QUALIFICATIONS OF TRAINING SPECIALISTS

A. The Contractor shall submit the equipment manufacturer's documentation of the qualifications of their proposed training specialists for approval by the Engineer sixty (60) days prior to the date of proposed training. The documentation shall include the experience of the training specialists in operation and maintenance of the equipment and a summary of training experience. The documentation shall be submitted for approval with the lesson plan submittal. Lesson plans that do not include such documentation will be considered incomplete.

B. Only those training specialties whose qualifications have been approved by the Engineer shall conduct training.

1.12 TRAINING SCHEDULE AND OPERATION & MAINTENANCE MANUALS

A. Provide the County with adequate time requirements for manufacturer's training, minimum training times for various pieces of equipment and systems are listed on the attached schedule. Schedule 01730-A also references sections that will require an Operation & Maintenance Manual.

1. Schedule 01730-A: Schedule of specification sections requiring an Operations and Maintenance Manual:

Training Schedule Specification Sec.	Description of Equipment	Minimum Training Time
11610	Integrally Geared Single-Stage Centrifugal Blowers	Refer to Section 11610
13404	Process Control System	Refer to Sections: 13401, 13402, 13403, & 13404
13420	Primary Sensors and Field Instruments	8 hours
13451	PLC Hardware and Software	8 hours
14602	Lifting Equipment	4 hours
15000	Misc. HVAC Equipment	Refer to Section 15000
16442	Elect. Control Equip. Low Voltage AC Motors & Devices	16 hours
16482	Motor Control Centers	24 hours
16491	Fuses	1 hour
16496	Automatic Transfer Switches	8 hours
16511	Light Fixtures and Devices	8 hours
16923	Variable Frequency Controllers	16 hours
16701	Distributed Antenna System	4 hours

++ END OF SECTION ++

SECTION 01733

CONSTRUCTION WASTE MANAGEMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for construction waste management.

1.2 SUBMITTALS

A. The Contractor shall prepare and submit a Construction Waste Management Plan for review and approval by the Engineer within fifteen (15) days after receipt of Notice to Proceed and prior to the removal of any construction waste or demolition materials from the Project site.

B. The Construction Waste Management Plan shall contain the following:
   1. Analysis of the proposed job site waste to be generated during the full construction period, including types and anticipated quantities of each. The list of construction waste materials shall include, at a minimum but not limited to, the following materials:
      a. Cardboard
      b. Clean dimensional wood
      c. Demolition debris
      d. Concrete
      e. Bricks
      f. Concrete masonry units (CMU)
      g. Asphalt
      h. Metals from rebar, sheetrock studs, framing, etc.
      i. Steel sheet piling
      j. Steel pipe piles
      k. Structural steel
      l. Paints, solvents, and other hazardous fluids
      m. Glass
      n. Roofing
      o. Wood pallets
      p. Fencing materials
      q. Mercury containing light bulbs/batteries
      r. Recyclable office wastes such as paper and toner and ink cartridges that should be recycled.

   2. Materials Handling Procedures: A description of the means by which any construction waste materials listed above will be appropriately segregated and not mixed in order to prevent cross-contamination as well as a description of the

means to be employed in recycling the above materials consistent with requirements of the County.

3. The Construction Waste Management Plan shall specify a list of waste transporters, transfer stations, disposal facilities and recyclers with addresses, phone numbers, and permits which the Contractor intends to utilize during the construction period for the purpose of complying with the Construction Waste Management Plan. The Plan should list where the non-recyclable materials will be disposed.
4. Transportation: A description of the means of transportation of the recyclable and non-recyclable materials (whether materials will be site-separated and self- hauled to designated centers, or whether mixed materials will be collected by a waste transporter and removed from the site) and destination of such materials.
5. Hazardous wastes: The Construction Waste Management Plan shall specifically note the proper method of disposal for anticipated hazardous wastes or potentially hazardous wastes such as resins, epoxies, waterproofing agents, waste paints, solvents, and other hazardous fluids, expended 55 gallon drums, concrete curing compounds, etc. The Plan shall state that the hazardous waste transporter must hold a current DEC Part 364 Waste Transporter Permit. The permit must authorize the transporter to take the hazardous waste to the Transportation, Storage and Disposal Facility (TSDF) identified in the permit. The Construction Waste Management Plan must state that the hazardous waste will be transported in compliance with USDOT 49 CFR Hazardous Materials Transportation regulations.
6. Universal wastes: The Construction Waste Management Plan shall specifically identify the proper method of handling of universal wastes (e.g., mercury containing bulbs, batteries). Universal wastes must be managed in compliance with 6NYCRR Part 374-3 and with USDOT 49 CFR Hazardous Materials Transportation regulations.
7. Non-hazardous wastes: The Construction Waste Management Plan shall specifically note the proper method of disposal of anticipated non-hazardous waste such as oily rags. The Plan shall state the transporter must hold a current Part 364 Waste Transporter Permit to transport the waste to a TSDF that accepts non-hazardous waste.
8. The Construction Waste Management Plan shall include the method of recycling office materials such as clean white paper, mixed paper, toner cartridges for laser printers, copiers, and fax machines. Each item shall be recycled in accordance with the manufacturer's instructions.
9. The Construction Waste Management Plan shall include the coordination of product deliveries to designated prepared areas in order to minimize site storage time and potential damage to stored materials and the return of packing materials, such as wood pallets, fifty-five (55)-gallon drums, etc., where economically feasible.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT

A. The Contractor shall use construction and demolition methods and processes to ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors. Where economically feasible, as many of the materials from the generated waste shall be salvaged, reused, or recycled.

B. When encountered as part of his work, the Contractor shall dispose of construction and demolition waste by recycling methods in accordance with all relevant State, County and local codes, laws, and regulations.

C. All hazardous waste, universal waste, and used oil must be separated and stored in their own dedicated storage areas and managed in compliance with NYSDEC Hazardous Waste, Universal Waste and Used Oil Regulations and USDOT 49 CFR Hazardous Material Transportation Regulations.

3.2 HANDLING AND STORAGE

A. The Contractor shall designate separate receiving/storage areas for delivered materials and equipment to minimize waste due to excessive materials mishandling, misapplication, weather, and other damage.

B. The requirements herein shall supersede any conflicting statements wherever they may appear in the Contract Documents.

+ + END OF SECTION + +

+ + NO TEXT ON THIS PAGE + +

SECTION 01760

PROJECT CLOSEOUT

PART 1 – GENERAL

1.1 FINAL CLEANING

A. At the completion of the Work, the Contractor shall remove temporary structures, construction signs, tools, scaffolding, materials, supplies and equipment which they or any of their Subcontractors may have used in the performance of the Work.

B. The Contractor shall broom clean paved surfaces and rake clean other surfaces of grounds.

C. The Contractor shall thoroughly clean all materials, equipment and structures; all marred surfaces shall be touched up to match adjacent surfaces; dirty filters and burned-out lights replaced as required. The Contractor shall clean and polish all interior and exterior glass surfaces so as to leave glass surfaces in a clean and new appearing condition.

D. The Contractor shall remove spatter, grease, stains, fingerprints, dirt, dust, labels, tags, packing materials, rubbish, and other foreign items or substances from interior and exterior surfaces, equipment, signs and lettering.

E. Remove paint, clean and restore all equipment and material nameplates, labels and other identification markings.

F. The Contractor shall maintain cleaning until Project, or portion thereof, is occupied by the County.

1.2 INSPECTIONS

A. At the time of substantial completion an inspection shall be held in accordance with the requirements of the Agreement, Article XXXVI, "Substantial Completion Payment". At this time the Contractor shall also provide all necessary documentation as required by the above referenced Article.

B. At the time of completion of all the Work a final inspection shall be held in accordance with the requirements of the Agreement, Article XXXVII, "Final Payment". The Contractor shall also provide all necessary documentation as required by the above referenced Article, and comply with all the requirements of the General Conditions, Article GC-38, "Project Closeout".

C. Follow-up Inspection:

1. At the time of the completion of the guarantee period as specified in the Agreement, Article XX, "Maintenance and Guarantee," the Engineer will make arrangements with the County and the Contractor for a follow-up inspection and will send a written notice to said parties to inform them of the date and time of the inspection.
2. After the inspection, the Engineer will inform the Contractor of any corrections required.
3. When the corrections have been satisfactorily completed, the Engineer will forward a certificate for the release of Bonds.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 01770

MINORITY/WOMEN'S BUSINESS ENTERPRISE
PROGRAM AND EQUAL EMPLOYMENT
OPPORTUNITY REQUIREMENTS

1.1 GENERAL REQUIREMENTS

A. The Contractor shall comply with all federal, state, and local statutory and constitutional anti-discrimination provisions. In addition, Local law No. 14-2002, entitled "Participation by Minority Group Members and Women in Nassau County Contracts" governs all County Contracts. In accordance with Local law 14-2002:

a) The Contractor shall not discriminate against employees or applicants for employment because of race, creed, color, national origin, sex, age, disability or marital status in recruitment, employment, job assignments, promotions, upgradings, demotions, transfers, layoffs, terminations and rates of pay or other forms of compensation. The Contractor will undertake or continue existing programs related to recruitment, employment, job assignments, promotions, upgradings, transfers, and rates of pay or other forms of compensation to ensure that minority group members and women are afforded equal employment opportunities without discrimination.

b) At the request of the County contracting agency, the Contractor shall request each employment agency, labor union, or authorized representative of worker with which it has a collective bargaining or other agreement or understanding, to furnish a written statement that such employment agency, union, or representative will not discriminate on the basis of race, creed, color, national origin, sex, age, disability, or marital status and that such employment agency, labor union, or representative will affirmatively cooperate in the implementation of the Contractor's obligations herein.

c) The Contractor shall state, in all solicitations or advertisements for employees, that, in the performance of the County Contract, all qualified applicants will be afforded equal employment opportunities without discrimination because of race, creed, color, national origin, sex, age, disability or marital status.

d) The Contractor shall make its' best efforts to solicit active participation by "Certified business enterprises (as defined in Section 101 of Local law No. 14-2002).

e) The Contractor shall be bound by the provisions of Section 109 of Local law No. 14-2002 (entitled "Enforcement").

f) The Contractor shall include the provisions of (a) through (e) above in every subcontract providing for a total expenditure in excess of twenty-five thousand dollars ($25,000) for the construction, demolition, replacement, major repair, renovation, planning or design of real property and improvements thereon (the "Work"), except where the Work is for the beneficial use of the Contractor.
The provisions of (a) through (f) above do not apply to: (i) work, goods or services unrelated to the County Contract, or (ii) employment or employment related activities outside of the County.

The term "County Contract" means (i) a written agreement or purchase order instrument, providing for a total expenditure in excess of twenty-five thousand dollars ($25,000), whereby a County contracting agency is committed to expend or does expend funds in return for labor, services, supplies, equipment, materials or any combination of the foregoing, to be performed for, or rendered or furnished to the County; or (ii) a written agreement in excess of one hundred thousand dollars ($100,000), whereby a County contracting agency is committed to expend or docs expend funds for the acquisition, construction, demolition, replacement, major repair or renovation of real property and improvement thereon. However, the term "County Contract" does not include agreements or orders for the following services: banking services, insurance policies or contracts, or contracts with a County contracting agency for the sale of bonds, notes or other securities.

The term "Contractor" means an individual, business enterprise, including sole proprietorship, partnership, corporation, not-for-profit corporation, or any other person or entity other than the County, whether a contractor licensor, licensee or any other party, that is (i) a party to a County Contract, (ii) a bidder in connection with the award of a County Contract, or (iii) a proposed party to a County Contract.

++ END OF SECTION ++

SECTION 01812

COMMISSIONING SUMMARY

1.1 GENERAL REQUIREMENTS

A. This Section specifies the Contractor's responsibilities in the commissioning process. Commissioning requires the participation of the Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents.

B. The commissioning process integrates the traditionally separate functions of system documentation, equipment startup, performance testing and training. Commissioning during the construction phase is intended to achieve the following specific objectives in accordance with the Contract Documents:

1. Verify and document that applicable equipment and systems are installed according to the manufacturer's recommendations, contract requirements, and industry standards, and that they receive adequate operational checkout by installing contractors.

2. Verify and document proper performance of equipment and systems.

3. Verify and document that O&M documentation is complete.

4. Verify and document that Owner personnel are properly trained.

C. The systems and equipment to be commissioned are listed in this Section. The Contractor's general commissioning requirements and coordination are detailed in this Section. Specific requirements for commissioning of each system or piece of equipment are detailed in the specification Section for the individual systems or pieces of equipment. A detailed description of the overall commissioning process is included in the Schedule.

D. The commissioning process does not reduce the responsibility of the Contractor to provide finished and fully functional systems and equipment.

1.02 - SYSTEMS TO BE COMMISSIONED

A. The following systems will be commissioned in this project. Specific requirements for the commissioning of each system are included in the related specification Section.

1. Process Aeration Blowers

2. Instrumentation and Control / SCADA System

3. Butterfly Valves with Actuators

4. Exhaust Fans

5. Heaters

B. Example Commissioning Documents: Equipment and system specific Pre-Functional Checklists and Functional Test procedures will be developed by the Commissioning Authority based on approved submittals, and then will be provided to the Contractors.

1.03 – DEFINITIONS

A. Acceptance Phase: Phase of construction after startup and initial checkout when functional performance tests, O&M documentation review and training occurs.

B. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes in accordance with the Contract Documents.

C. Commissioning Plan: An overall plan that provides the structure, schedule and coordination planning for the commissioning process.

D. Commissioning Team: The members of the commissioning team consist of the Owner's representative (s), the Contractor, the architect/engineer.

E. Deferred Functional Tests: Functional tests that are performed after substantial completion, due to partial occupancy, seasonal requirements, design or other site conditions that prevent the test from being performed prior to substantial completion.

F. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents.

G. Factory Testing: Testing of equipment on-site or at the factory by factory personnel.

H. Functional Performance Test (FT): Test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The Contractor develops the functional test procedures in sequential written form. The Owner's representative coordinates, oversees and documents the actual testing. The Contractor performs the functional tests. FTs are performed after prefunctional checklists and startup is complete.

I. Phased Commissioning: Commissioning that is completed in phases (by floors, for example) due to the size of the structure or other scheduling issues, in order to minimize the total construction time. Commissioning shall be provided for each phase according to the schedule for that phase. Some repetition and/or remobilization may be required.

J. Prefunctional Checklist (PC): A list of items to inspect and component tests to conduct to verify proper installation of equipment prior to initiating functional testing.

K. Startup: The initial starting or activating of dynamic equipment, including executing prefunctional checklists.

1.04 – COORDINATION

A. All members of the commissioning team shall work together to fulfill their contractual responsibilities and meet the objectives of the Contract Documents.

Integrate all commissioning activities into the approved progress schedule. All parties will address scheduling problems and make necessary notifications and changes in a timely manner in order to expedite the commissioning process and maintain the approved progress schedule.

1.05 - COMMISSIONING PROCESS

A. Commissioning Plan. The commissioning plan provides guidance in the execution of the commissioning process. Following the initial commissioning scoping meeting the Owner's representative will update the plan which is then considered the "final" plan, although it may be revised as the project progresses.

B. Commissioning Process. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur. A more detailed description of the commissioning process can be found in the Appendix.

1. Commissioning during construction begins with a scoping meeting conducted by the Owner's representative where the commissioning process is reviewed with the Commissioning Team.

2. Additional meetings will be required throughout construction, scheduled by the Owner's Representative, to plan, scope, coordinate, and schedule future activities and to resolve problems. When possible, commissioning meetings will be scheduled immediately following construction meetings.

3. Equipment documentation is submitted to the Engineer during the submittal process, including detailed start-up procedures.

4. The Owner's representative works with the Contractor to develop startup activity lists and startup documentation. The Owner's representative provides pre-functional checklists to be completed by the Contractor during the startup process.

5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels. In each case prefunctional checklists are completed, submitted, and approved before functional testing begins.

6. The Contractor executes and documents the prefunctional checklists, and provides notification to the Owner's Representative. The Contractor performs startup and initial checkout. The Owner's representative documents that the checklists and startup were completed according to the approved plans.

7. The equipment manufacturer develops specific equipment and system functional performance test procedures. The Contractor reviews the procedures and submits suggestions or comments. Procedures are finalized by the Owner's representative.

8. The procedures are executed by the Contractor.

9. Items of non-compliance in material, workmanship, or setup are corrected and retested at the Contractor's expense. The Contractor is responsible for providing all resources, manpower, and materials necessary to rectify deficiencies as per requirements of the approved schedule.

10. The O&M documentation prepared by the Contractor is reviewed for completeness by the Owner's representative.

11. Commissioning is completed before Substantial Completion.

12. The Owner's representative reviews, pre-approves and coordinates the training provided by the Contractor and verifies that is was completed.

13. Deferred testing is conducted, as specified or required.

1.06 - CONTRACTOR'S RESPONSIBILITIES

A. The Contractor's commissioning responsibilities are as follows (all references apply to commissioned systems and equipment only):

1. Construction and Acceptance Phase:

a. Attend the commissioning scoping meeting and other necessary meetings scheduled by the Owner's Representative to facilitate the commissioning process.

b. Facilitate the coordination of the commissioning work by the Owner's representative, and with the Owner's representative ensure that commissioning activities are being scheduled into the approved progress schedule.

c. Provide detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, factory test reports, and full warranty information, including all responsibilities of the Director to keep the warranty in force. The installation, start-up and checkout materials that are actually shipped with the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Owner's representative. The Owner's representative may request further documentation necessary for the commissioning process.

d. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.

e. Ensure that all subcontractors execute their commissioning responsibilities according to the Contract Documents and approved progress schedule.

f. Assist in the process of writing detailed test procedures by clarifying the operation and control of commissioned equipment.

g. Review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

h. Develop a full start-up and testing plan using manufacturer's start-up procedures and the prefunctional checklists from the Owner's representative for all commissioned equipment. Submit to the Owner's representative for review and approval prior to startup.

i. During the startup and initial checkout process, execute all portions of the prefunctional checklists for all commissioned systems and equipment. Verify that system installations include all ports, gages, thermometers, access doors, valves, etc., required for specified functional performance testing.

j. Provide all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment.

k. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Owner's representative.

l. Address incomplete Work before functional performance testing.

m. Provide skilled technicians to execute startup of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

n. Provide skilled technicians to perform functional performance testing under the direction of the Owner's representative for specified equipment. Provide Manufacturer's Representative as required and as specified in the Specification. Assist the Owner's representative in interpreting the monitoring data, as necessary.

o. Correct deficiencies (differences between specified and observed performance) as directed by the Owner's Representative.

p. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions. Provide a copy of the O&M manuals and submittals of commissioned equipment to the Owner's representative for review and approval.

q. Provide training as specified.

r. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

2. Warranty Period:

a. Execute seasonal or deferred functional performance testing in accordance with the specifications.

b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

PART 2 – PRODUCTS

2.01 - TEST EQUIPMENT

A. All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the Contractor.

B. Specified special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment shall be provided by the Contractor, and turned over to the Owner at the completion of the Work.

C. Datalogging equipment and software required to test equipment shall be provided by the Contractor, but shall not become the property of the Owner.

D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

PART 3 – EXECUTION

3.01 MEETINGS

A. Scoping Meeting. Prior to the commencement of construction, the Owner's representative will schedule, plan and conduct a commissioning scoping meeting with the Commissioning Team.

B. Miscellaneous Meetings. Other meetings will be planned and conducted by the Owner's representative as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with the Contractor, appropriate sub-contractors and suppliers and the Engineer.

3.02 - START-UP, PREFUNCTIONAL CHECKLISTS, AND INITIAL CHECKOUT

A. Prefunctional checklists and initial checkout shall ensure that the equipment and systems are hooked up and operational. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional performance testing of systems or equipment.

B. Start-up and Initial Checkout Plan. The Engineer shall assist the commissioning team members responsible for startup of any equipment in reviewing detailed start-up plans for all equipment. The primary role of the Engineer in this process is to ensure that there is written documentation that each of the manufacturer's recommended procedures have been completed.

C. Execution of Prefunctional Checklists and Startup.

1. Four weeks prior to startup, the Contractor shall schedule startup and checkout with the Owner's Representative.

2. The Contractor shall execute startup and provide the Engineer with a signed and dated copy of the completed start-up and prefunctional tests and checklists.

3.03 - FUNCTIONAL PERFORMANCE TESTING

A. Development of Test Procedures. Using the requirements in the specifications, develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Prior to testing, provide a copy of the test procedures to the Engineer who shall review the tests for feasibility, safety, equipment and warranty protection.

B. Functional performance testing shall document that each system is operating in accordance with the Contract Documents. During the testing process, areas of deficient performance shall be identified. Deficiencies shall be corrected by the Contractor and functional testing shall be re-scheduled. The Contractor shall be responsible for all costs associated with re-testing for functional performance.

C. Each system shall be operated through all modes of operation. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.

D. Test Methods. Each function and test shall be performed under conditions that simulate actual conditions as closely as possible. The Contractor shall execute the test and shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At the completion of the test, the Contractor shall return all building equipment and systems affected by these temporary modifications to their pre-test condition.

3.04 - OPERATION AND MAINTENANCE MANUALS

A. O&M Manuals. The specific content and format requirements for the O&M manuals are detailed in Section 01730.

B. Compile and prepare commissioning documentation for all equipment and systems and include this information in the O&M manuals.

3.05 - TRAINING

A. Coordinate, schedule, and document that all required training has been completed successfully.

B. The Contractor shall have the following training responsibilities:

1. Provide a training plan not less than two weeks before the planned training.

2. Provide comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.

3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment.

4. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

5. Training shall include:

a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.

b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, and any emergency procedures.

c. Discussion of relevant health and safety issues and concerns.

d. Discussion of warranties and guarantees.

e. Common troubleshooting problems and solutions.

f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.

g. Discussion of any peculiarities of equipment installation or operation.

3.06 - DEFERRED TESTING

A. Unforeseen Deferred Tests. If any check or test cannot be completed due to project conditions, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the Owner's Representative. These tests will be conducted in the same manner as the seasonal tests as soon as possible.

B. Seasonal Testing. Seasonal testing (tests delayed until weather conditions are closer to the system's design conditions) shall be completed as part of this Contract. Make any final adjustments to the O&M manuals and as-builts resulting from information gained during testing.

3.07 - SCHEDULE

B. Verify Instrumentation and Control / SCADA System are operating as required.

C. Verify flow and DO measurement devices are accurate.

D. Verify butterfly valves fully open and fully close.

E. Verify the valve actuators are modulating as required.

F. Verify the ventilation system and heating system operate as required.

G. Turn off lead blower(s) to demonstrate operation of back-up blower.

K. Conduct 10-day test to demonstrate operation of entire aeration blower facility.

++ END OF SECTION ++

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SECTION 02050

DEMOLITION, REMOVALS, AND MODIFICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified, and required to complete the Work of demolition, removal, and disposal. Included are all modifications to existing facilities as shown and required to complete the Work.
   2. Included, but not limited to, are the demolition, removal, and disposal of existing structures, removal and disposal portions of any existing equipment including piping not required for the operation of the plant as indicated on the Drawings and as specified hereinafter.
   3. The Contractor shall furnish all labor, materials and equipment to demolish portions of structures and to remove anchors, supports, piping, equipment and accessories designated to be removed on the Drawings.
   4. The removal of all equipment, piping, and all other materials from the demolition of structures shall, when released by the Engineer, be done by the Contractor for the materials removed by him and shall become Contractor's property, unless otherwise noted. The debris shall be disposed of off site in a manner not contrary to the Contract requirements.

B. Related Sections:
   1. Section 02200, Earthwork.

1.2 SUBMITTALS

A. Schedule: Submit for approval the following:
   1. The Contractor shall submit a detailed description of methods and equipment and sequence for demolition and removal for the Engineer's review.

1.3 PROTECTION

A. General:
   1. Demolition and removal Work shall be performed by competent workmen experienced in the various types of demolition and removal Work required, and shall be carried through to completion with due regard to the safety of the Owner’s employees, workmen on the Site and the public. The Work shall be performed with as little nuisance as possible.
   2. The Work shall comply with the applicable provisions and recommendation of ANSI A10.2, Safety Code for Building Construction, and all governing codes and as hereinafter specified.
   3. The Contractor shall make such investigations, explorations and probes as are necessary to ascertain any required protective measures before proceeding with demolition and removal.
   4. The Contractor shall provide interior and exterior shoring, bracing and support to prevent movement, settlement, or collapse of existing structures or facilities. The Owner assumes no responsibility for the actual condition of the structures or facilities adjacent to the Work or the structures or facilities designated for removal or modification.
   5. Do not bring explosives on site. No explosives will be permitted for this Project.

B. Execution:
   1. The Contractor shall provide, erect and maintain catch platforms, lights, barriers, weather protection, warning signs and other items as required for proper protection of the public, occupants of the building, workmen engaged in demolition operations, and adjacent construction.

2. The Contractor shall provide and maintain weather protection at exterior openings so as to fully protect the interior premises against damage from the elements until such openings are closed by new construction.
3. The Contractor shall provide and maintain temporary protection of the existing structure designated to remain where demolition, removal and new Work is being done, connections made, materials handled, or equipment moved.
4. The Contractor shall take necessary precautions to prevent dust from rising by wetting demolished masonry, concrete, plaster and similar debris. Unaltered portions of the existing buildings affected by the operations under this Section shall be protected by dustproof partitions and other adequate means.
5. The Contractor shall provide adequate fire protection in accordance with local Fire Marshal requirements.
6. The Contractor shall not close or obstruct walkways, passageways, or stairways and shall not store or place materials in passageways, stairs or other means of egress. The Contractor shall conduct operations with minimum traffic interference.
7. The Contractor shall be responsible for any damage to the existing structure or contents by reason of the insufficiency of protection provided.
8. The Contractor shall carry out all operations so as to avoid interference with operations and work in the existing facilities and the work under other contracts.
9. The Contractor shall be solely responsible for making all necessary arrangements and for performing all necessary work involving the discontinuance or interruption of all utilities or services.
10. Any equipment, piping and appurtenances removed without proper authorization, which are necessary for the operation of the existing plant or of the plant expansion, shall immediately be replaced to the satisfaction of the Engineer at no cost to the Owner.

C. Notification:
1. At least 48 hours prior to commencement of demolition or removal, the Contractor shall notify the Engineer in writing of his proposed schedule therefor. The Owner shall inspect the existing equipment and (review with the Contractor) those items that are to remain the property of the Owner. No removals shall be started without the permission of the Engineer.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. The Work required shall be done with care, and shall include all required shoring, bracing, etc. The Contractor shall be responsible for any damage which may be caused by demolition and removal Work to any part or parts of existing structures or items designated for reuse or to remain. The Contractor shall perform patching, restoration and new Work in accordance with applicable technical sections of the Specifications and in accordance with the details shown on the Drawings.

B. Surfaces of walls, or other areas which are exposed by any of the removals specified herein, and which will remain as architecturally finished surfaces, which have holes, scars, chipped or other damaged surfaces revealed by the removal shall be repaired by the Contractor with the same or matching materials as the existing surface or as may be otherwise approved by the Engineer.

C. Pollution Controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.

1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
2. Clean adjacent structures, facilities, and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of the Work.

D. All supports, pedestals and anchors shall be removed with the equipment and piping unless otherwise specified or required. The concrete bases, anchor bolts and other supports shall be removed to approximately one inch below the surrounding finished area and the recesses shall be patched to match the adjacent areas. The superstructure wall and roof openings shall be closed, and damaged surfaces shall be patched to match the adjacent areas, as specified under applicable sections of the Specifications, as shown on the Drawings, or as directed by the Engineer. Wall sleeves and castings shall be plugged or blanked off, all openings in concrete shall be closed in a manner meeting the requirements of the appropriate sections of the Specifications, as shown on the Drawings and as directed and approved by the Engineer.

E. Deposition of Materials and Equipment:
1. The Contractor shall dispose of all demolition materials, equipment, debris, and all other items not marked by the Owner to remain as property of the Owner, off the site and in conformance with all existing applicable laws and regulations.

F. Wherever piping is to be removed for disposition, the piping shall be drained by the Contractor and adjacent pipe and headers that are to remain in service shall be blanked off or plugged and then anchored in an approved manner.

G. Where alterations occur, or new and old Work join in, the Contractor shall cut, remove, patch, repair or refinish the adjacent surfaces to the extent required by the construction conditions, so as to leave the altered Work in as good a condition as existed prior to the start of the Work. The materials and workmanship employed in the alterations, unless otherwise shown on the Drawings or specified, shall comply with that of the various respective trades, which normally perform the particular items of work.

H. The Contractor shall remove temporary work, such as enclosures, signs, guards, and the like when such temporary work is no longer required or when directed at the completion of the Work.

3.2 STRUCTURAL REMOVALS

A. The Contractor shall remove concrete and structures to the lines and grades shown unless otherwise directed by the Engineer. Where no limits are shown, the limits shall be 4 inches outside the item to be installed.

B. Determine the thickness of existing concrete to be removed and the extent to which it is reinforced. No additional compensation will be made because of variations from the thickness shown or for variations in the amount of reinforcement.

C. All concrete, concrete block, reinforcement, structural or miscellaneous metals, plaster, wire mesh and other items contained in or upon the structure shall be removed and taken from the site, unless otherwise approved by the Engineer. Demolished items shall not be used in backfill.

D. After removal of parts or all of slabs and like work which tie into new Work or existing work, the point of junction shall be neatly repaired so as to leave only finished edges and finished surfaces exposed.

E. Where new anchoring materials including bolts, nuts, hangers, welds and reinforcing steel are required to attached new Work to the existing work, they shall be included under this Section, except where specified elsewhere.

3.3 PAVEMENT, CURB AND SIDEWALK REMOVALS

A. Remove existing pavement, including bases and surface courses, stabilized sub-bases, curbs, and gutters as required to construct new facilities or as shown. Before removing, saw a straight joint at least 1-1/2-inches deep between sidewalk and pavement designated for removal and that left in place. Curbs and gutters shall be removed to the nearest construction joint beyond the end of demolition symbol shown on the Drawings.

B. Determine the thickness of existing pavement, base, sub-base, curb, gutter, driveway pavement, and sidewalk to be removed, and the extent to which they are reinforced. No additional compensation will be made because of variations from the assumed thickness or from the thickness shown or for variations in the amount of reinforcement.

C. Provide for satisfactory transition between replaced pavement and sidewalks and the portions remaining in place.

3.4 MECHANICAL REMOVALS

A. Equipment removals shall consist of dismantling and removing of existing piping, equipment, and other appurtenances as specified, shown, or required for the completion of the Work. It shall include cutting, capping, draining, and plugging as required, except that the cutting of existing piping for the purpose of making connections thereto will be included under Division 15.

B. When underground piping is to be altered or removed, the remaining piping shall be properly capped. Abandoned underground piping may be left in place unless it interferes with new Work or is shown or specified to be removed.

C. Any demolition or changes to potable water piping and other plumbing and heating system work shall be made in conformance with all applicable codes. Portions of the potable water system that may have been altered or opened shall be pressure tested and disinfected in accordance with Division 15 and local codes. Other plumbing piping and heating piping shall be pressure tested only.

D. Provide all caps, plugs, blind flanges, shut-off valves and other work and materials required to remove from service existing piping and necessary to keep existing piping in service where shown or required.

3.5 MISCELLANEOUS REMOVALS

A. The Contractor shall remove miscellaneous concrete walls, slabs, pipe supports, and curbs where shown on the Drawings or where necessary for the construction of new structures or modification of existing structures.

3.6 MODIFICATIONS AND CLOSURES

A. Modifications shall conform to all applicable Specifications, the Drawings, and the directions and approvals of the Engineer.

B. Where alterations require cutting or drilling into existing floors and walls the holes shall be repaired in an approved manner. The Contractor shall repair such openings with the same or

matching materials as the existing floor, wall, or roof or as otherwise approved by the Engineer. All repairs shall be smoothly finished unless otherwise approved by the Engineer.

C. Where parts of existing structures are to remain in service, demolish the portions to be removed, repair damage, and leave the structure in proper condition for the intended use. Remove concrete and masonry to the lines designated by drilling, chipping, and other suitable methods. Leave the resulting surfaces true and even, with sharp straight corners that will result in neat joints with new construction or be satisfactory for the purpose intended. Where existing reinforcing rods are to extend into new construction, remove the concrete so that the reinforcing is clean and undamaged. Cut off other reinforcing flush with the surface.

D. New Work shall be keyed into the existing in an acceptable manner. New reinforcing steel shall be welded to the existing reinforcing. Welding shall conform to AWS D12.1, Reinforcing Steel Welding Code. In general, the same or matching materials as the existing adjacent surface shall be used. The finished closure shall be a smooth, tight, sealed, permanent closure with all exposed surfaces smooth finished and acceptable to the Engineer.

3.7 TITLE TO EQUIPMENT AND MATERIALS

A. The Contractor shall have no right or title to any of the equipment, materials or other items to be removed from the existing buildings or structures unless and until said equipment, materials and other items have been removed from the premises. The Contractor shall not sell or assign, or attempt to sell or assign any interest in the said equipment, materials or other items until the said equipment, materials or other items have been removed.

B. The Contractor shall have no claim against the Owner because of the absence of such fixtures and materials.

3.8 CONDITION OF BUILDINGS, STRUCTURES AND EQUIPMENT

A. The Owner does not assume responsibility for the actual condition of buildings, structures and equipment to be demolished and removed.

B. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner so far as practicable.

C. The information regarding the existing structures and equipment shown on the Drawings is based on visual inspection and a walk-through survey only. Neither the Engineer nor the Owner will be responsible for interpretations or conclusions drawn therefrom by the Contractor.

3.9 MAINTENANCE AND CLEAN UP

A. The Contractor shall maintain the buildings, structures and public properties free from accumulations of waste, debris and rubbish, caused by the demolition and removal operations.

B. The Contractor shall provide on-site dump containers for collection of waste materials, debris and rubbish, and they shall wet down dry materials to lay down and prevent blowing dust.

C. At least once a week during the progress of the demolition and removal Work or as directed by the Engineer, the Contractor shall clean the Site and properties (including sweeping roadways with a mechanical sweeper), and dispose of waste materials, debris and rubbish.

+ + END OF SECTION + +

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SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. The Contractor shall perform all excavating, backfilling and disposing of earth materials as shown, specified, and required for the purpose of site preparation, erosion control, surface drainage, constructing pipelines, concrete work, installation and removal of sheeting and bracings, grading, and other facilities.
   2. Also included is earthwork necessary for repair and replacement of roads, walks, pavements, grading, structures and other facilities as required to complete the Work as shown and specified. All materials necessary for fill, backfill, granular embedment and crushed stone are included.
   3. This Section also includes providing all backfill materials, including select fill, common fill, granular embedment, topsoil, crushed stone, and the satisfactory disposal of surplus and unacceptable materials.
   4. All necessary preparation of subgrade is included.
   5. All temporary means needed to prevent discharge of sediment to water courses from dewatering systems or erosion are included.

B. Sources of Materials:
   1. General fill materials shall be obtained from on-site excavation work.
   2. Select fill materials shall be obtained from on-site sources.
   3. Crushed stone materials shall be obtained from off-site sources.
   4. Topsoil, except for topsoil stripped from the Work areas that meets the requirements specified under Section 02485, shall be obtained from off-site sources.

C. Related Sections:
   1. Section 02050, Demolition, Removals and Modifications.
   2. Section 02110, Clearing.
   3. Section 02485, Grassing and Plantings.
   4. Section 02500, Pavement.
   5. Section 02529, Concrete Curbs, Gutters, and Sidewalks.
   6. Section 03300, Cast-In-Place Concrete.
   7. Section 15051, Buried Piping Installation.

1.2 QUALITY ASSURANCE

A. Permits and Regulations:
   1. The Contractor shall perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

B. Design Criteria:
   1. All steel work for sheeting, shoring, bracing and other related Work shall be in accordance with the provisions of the AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings," except that field welding will be permitted.
   2. The Contractor shall be wholly responsible for installing and operating the system used to accomplish the sheeting and bracing shown on the Drawings, or otherwise required.

C. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified.

1. ASTM A36, Structural Steel.
2. ASTM A328, Steel Sheet Piling.
3. ASTM D422, Particle-Size Analysis of Soils.
4. ASTM D698, Moisture-Density Relations of Soils, using 5.5 lb (2.5 kg) Rammer and 12-inch (304.8 mm) Drop.
5. ASTM D1556, Density of Soil in Place by the Sand-Cone Method.

D. Tests:
1. The Owner will make tests and determine acceptability of the fill or material as listed below.
2. Required Tests:
   a. Select Fill Samples: Gradation, ASTM D422.
   b. Compacted Select Fill: Compaction, ASTM D698 and ASTM D1556.
3. Testing laboratory will submit copies of the following reports directly to the Engineer with copy to the Contractor:
   a. Gradation tests on borrow material.
   b. Field density tests.
   c. Optimum moisture-maximum density curve for each soil used for backfill.

1.3 SUBMITTALS

A. Contractor shall prepare drawings for the following items:
1. Sheeting and bracing, or other protective system(s).
2. Dewatering system.

Drawings shall be prepared by a Professional Engineer licensed in the State of New York and recognized as expert in the specialty involved. Drawings shall be submitted to Engineer for record purposes only. Calculations shall not be submitted. Drawing submittals will not be checked and will not imply approval by Engineer of the Work involved. Contractor shall be solely responsible for designing, installing, operating and maintaining whatever system is necessary to satisfactorily accomplish all necessary sheeting, bracing, protection, underpinning and dewatering.

B. Shop Drawings: Submit the following:
1. Sheeting and bracing, or other protective system(s).
2. Dewatering system.

Shop Drawings shall be prepared by a Registered Professional Engineer recognized as expert in the specialty involved. Also, submit for approval, calculations and all other pertinent information. Contractor, however, will be responsible for designing, installing, operating and maintaining the system(s) as required to satisfactorily accomplish all necessary sheeting, bracing, protection, and dewatering.

C. Samples: Submit for approval the following:
1. At least two weeks prior to the date of anticipated use, the Contractor shall submit, to the Owner, for approval, a representative sample of all on-site and off-site material required. The Contractor shall notify the Owner in writing of the source of each sample.

D. Manufacturer's Data: Submit for approval the following:
1. Manufacturer's specifications, performance characteristics and operating instructions for the compaction equipment.

1.4 JOB CONDITIONS

A. Site Information:
1. Existing boring information is included in the Supplemental Information.

2. Additional test borings and other exploratory operations may be made by the Contractor at no cost to the Owner.

B. Existing Structures:
   1. Shown on the Drawings are certain utilities, surface and underground structures located on or adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown for the convenience of the Contractor. The Contractor shall explore ahead of the required excavation to determine the exact location of all structures and utilities. They shall be supported and protected from injury by the Contractor. If they are broken or injured, they shall be restored immediately by the Contractor at no additional cost to the Owner.
   2. Prior to execution of the Work, the Contractor shall check and verify governing dimensions and elevations. The Contractor and the Owner shall jointly survey the condition of adjoining structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims.
   3. The Contractor shall establish benchmarks on all existing structures and submit the benchmark elevations to the Owner. The Contractor shall monitor elevations prior to dewatering and installation of sheet piling, and continue daily monitoring during the dewatering period and until sheet piling is removed or until directed to do so by the Engineer. The Contractor shall retain the services of a Licensed Land Surveyor, registered in the State of New York, to perform the monitoring work. All data shall be recorded and furnished to the Engineer daily. The Contractor shall immediately stop work and notify the Owner if any changes in benchmark elevations, additional cracking, sagging or other noticeable damage occurs. Work shall not proceed until the Contractor has the approval of the Owner.

C. Existing Utilities:
   1. Locate existing underground utilities in the areas of Work. If utilities are to remain in place, provide adequate means of protection during earthwork operations.
   2. Should uncharted or incorrectly charted piping or utilities be encountered during excavation, consult Owner in keeping respective services and facilities in operation. Repair damaged utilities to the satisfaction of the Engineer.
   3. Do not interrupt existing utilities serving facilities occupied and used by the Owner or others, except when permitted in writing by the Engineer and then only after acceptable temporary utility services have been provided.
   4. Demolish and completely remove existing underground utilities indicated to be removed. Coordinate with the Owner for shut-off of services if lines are active.

D. Protection of Persons and Property:
   1. Barricade open excavations occurring as part of this Work and post with warning lights. The Contractor shall provide "Jersey" type concrete barriers with reflective tape. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
   2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
   3. Consult the Engineer and obtain his approval before removing, trimming, or disturbing trees, shrubs, plants, fences, rails, walks, structures or other facilities that are encountered on the line of the excavation.
   4. Structures, utilities, sidewalks, pavements and other facilities removed or disturbed shall be replaced to their original condition, unless otherwise shown, specified or directed.

E. Dust Control: The Contractor shall conduct all of his operations and maintain the area of his activities, including sweeping and sprinkling of roadways, so as to minimize creation and dispersion of dust. In addition, the Contractor shall be responsible for controlling dust caused by his operation of vehicles and equipment, clearing or for any reason whatever, in accordance with Article GC-25 of the General Conditions.

F. Roadways and Walks: Excavated material and materials of construction shall be so deposited, and the Work shall be so conducted, as to leave open and free for pedestrian traffic all crosswalks, and for vehicular traffic a roadway not less than 10 feet in width. Hydrants, valves, and other facilities which may require access during construction shall be kept accessible for use. During the progress of the Work, the Contractor shall maintain such crosswalks, sidewalks, and roadways in satisfactory condition and the Work shall at all times be conducted so as to cause a minimum of inconvenience to the Owner.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Select Fill: Place select fill where shown or specified below and around structures, pipelines, roads, tanks, walks and other work. Well-graded granular material or bank run gravel, free from organic matter. Not more than 80 percent by weight shall pass through a No. 40 sieve; not more than 10 percent by weight through a No. 200 sieve; and 100 percent shall pass a 3-inch square sieve.

B. General Fill (Common Fill): Provide approved soil materials for backfill and fill, free of organics, clay, rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials and other deleterious matter. No more than 30 percent by weight shall pass through a No. 200 sieve except for topsoils.

C. Granular embedment: Crushed rock or pea gravel with not less than 95 percent passing a 1/2-inch sieve, not less than 95 percent retained on a No. 4 sieve and maximum 5 percent passing a No. 10 sieve.

D. Crushed stone: Crushed rock conforming to the following gradation:

Sieve Size	Percent Retained on Sieve
2 inch	0
1-1/2 inch	0-10
1 inch	30-65
3/4 inch	85-100
3/8 inch	95-100

2.2 FILTER FABRIC:

A. Filter fabric shall be a non-woven polypropylene material, needle punched or spunbonded fabric.

B. Filter fabric material, of non-woven plastic cloth meeting the following requirements, shall be installed as shown on the Contract Drawings.

Equivalent Opening Size	80-100 (U.S. standard sieve)
Open Area (%)	20-40
Pore Size Range (MM)	0.10 to 0.18
Thickness (mils)	30
Grab Strength (lbs)	120 (minimum)
Grab Elongation (%)	70
Burst Strength (psi)	125
Trapezoid Tear Strength (lbs)	70
Water Permeability Coefficient (K-cm/sec)*	0.07
Water Flow Rate (gal/min-ft^2)	480
Weight (ms/m^2)	140 (minimum)

*According to CFMC-FFET-2, "Falling-Head Water Permeability of Filter Fabrics".

C. Filter fabric shall be Mirafi 140S as manufactured by the Celanese Fibers Marketing Company, Celanese Corporation, or equal.

2.3 SHEETING, SHORING, AND BRACING

A. Wood Sheeting:
   1. Temporary Work: New or used timber meeting the requirements for Douglas Fir Dense Construction grade or Southern Pine No. 2 Dense S3.
   2. Permanent Work: New pressure treated (ACQ).

B. Steel Sheeting:
   1. Temporary Work: Steel conforming to ASTM A328. Steel for soldier piles, wales and braces may be new or used and shall conform to ASTM A36.
   2. Permanent Work: New or used rolled steel sections of the continuous interlocking type, conforming to ASTM A328.

C. Used materials shall be in good condition, capable of interlocking for entire length, not damaged or excessively pitted and acceptable to the Owner.

PART 3 - EXECUTION

3.1 INSPECTION

A. The Contractor shall provide the Engineer with sufficient time and means to examine the areas and conditions under which excavating, filling, and grading are to be performed. Work shall not proceed until all unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.2 SITE PREPARATION

A. The portions of the site on which the Work is to be constructed shall be cleared of all objectionable materials and debris (see Section 02110, Clearing).

3.3 STRIPPING AND STORING OF TOPSOIL

A. Topsoil is defined as friable clay loam surface soil found in a depth of not less than 6 inches. Topsoil shall be substantially free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material.

B. Strip topsoil which is satisfactory to whatever depths are encountered, and in such manner as to prevent intermingling with the underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping. Where trees are shown or directed to be left standing, stop topsoil stripping a sufficient distance from such trees to prevent damage to the main root system.

C. Stockpile topsoil in storage piles where approved by the Engineer. Construct storage piles to freely drain surface water. Cover storage piles to prevent windblown dust. Topsoil in excess of quantity required shall remain the property of the Owner. The Contractor shall stockpile and cover excess-stripped topsoil in an area approved by the Engineer.

3.4 EROSION CONTROL

A. General:
   1. In general, the construction procedures outlined herein shall be implemented to ensure minimum damage to the environment during construction.
   2. Whenever possible, access and temporary roads shall be located and constructed to avoid environmental damage. Provisions shall be made to regulate drainage, avoid erosion and minimize damage to vegetation. Special care shall be taken to eliminate depressions that could serve as mosquito pools.
   3. Where areas must be cleared for storage of materials or temporary structures, provisions shall be made for regulating drainage and controlling erosion, subject to the Engineer's approval.
   4. In the event of any temporary work stoppage, the Contractor shall take steps to prevent any temporary or permanent environmental damage to the area undergoing construction.

B. Control Measures:
   1. Temporary measures shall be applied to control erosion and to minimize the siltation of the existing drains, streambeds and natural ponding areas. Such measures shall include, but not be limited to, the use of berms, baled straw silt barriers, gravel or crushed stone, mulch, grasses, slope drains and other methods. These temporary measures shall be applied to erodible materials exposed by any activities associated with the construction of this Project.
   2. Temporary measures shall be coordinated with the construction of permanent drainage facilities and other work to the extent practicable to assure economical, effective, and continuous erosion and siltation control.
   3. The Contractor shall provide special care in areas with steep slopes. Disturbance of vegetation shall be kept to a minimum to maintain stability. Remove only those trees and shrubs and grasses that must be removed for construction. Protect the rest to preserve their aesthetic and erosion-control values.
   4. Install erosion and sediment control practices as specified herein. The practices shall be maintained in effective working condition during construction and until the drainage area has been permanently stabilized.
   5. Temporarily stabilize each segment of graded or otherwise disturbed land, including the sediment-control devices not otherwise stabilized by seeding and mulching or by mulching alone.

C. Temporary Seeding and Mulching:
   1. All disturbed areas shall be limed and fertilized prior to temporary seeding.
   2. Disturbed areas shall be maintained in a rough graded condition and temporarily seeded and/or mulched until completion of the Work.
   3. All areas on which temporary seeding has not been made by November 1st, shall be treated with mulch.
   4. Mulching shall be used in conjunction with seeding on critical areas and during poor weather. Use alone for temporary stabilization during months of November through April.
   5. Suitable Materials for Mulching:
      1) Unrotted straw or salt hay - 1-1/2 to 2 tons/acre.
      2) Wood-fiber or paper-fiber (hydroseeding) 1500 lbs./acre.
   6. Straw or salt hay mulches should be immediately anchored using peg and twine netting or a mulch anchoring tool or liquid mulch binders.
   7. After stabilization remove all straw bale dikes, debris, etc., from the site.
   8. Refer to Section 02485, Grassing and Plantings, for locations and types of permanent turf.

3.5 EXCAVATION

A. General:
   1. The Contractor shall perform all excavation required to complete the Work as shown and specified. All material excavated shall be unclassified. Excavations shall include all materials such as earth, sand, clay, gravel, hardpan, boulders, organic materials, decomposed rock, pavements, rubbish and all other materials within the excavation limits.

2. Excavations shall be open type where possible, shored and braced where necessary to prevent injury to workers and to new and existing structures or pipelines.
3. Excavations shall be made in the dry. Stockpile satisfactory excavated materials in areas approved by the Owner, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
4. Dispose of excavated material and waste materials as specified herein under Article 3.10, Disposal of Excavated Materials.

B. Pipeline Excavation:
1. No more than 100 feet of trench may be opened in advance of pipe laying.
2. Trench width shall be minimized to greatest extent practical but shall conform to the following:
   a. Sufficient to provide room for installing, jointing and inspecting piping, but in no case wider at top of pipe than pipe barrel outside diameter plus 2 feet.
   b. Enlargements at pipe joints may be made if required and approved by the Engineer.
   c. Sufficient for sheeting, bracing and sloping.
   d. Sufficient to allow thorough compacting of granular embedment adjacent to bottom half of pipe.
   e. Do not use excavating equipment which requires the trench to be excavated to excessive width.
3. At road crossings, trenching width shall be minimized by the use of sheeting, trench boxes on similar protection methods.
4. Where existing piping or ductbank cross the new pipeline or structural excavation, they shall be adequately supported and protected from damage due to construction. All methods for supporting and maintaining these facilities shall be subject to approval by the Engineer. Care shall be taken to insure that the existing pipeline grades and alignment are maintained and that the pipe joints are not disturbed. Backfill shall be carefully placed and tamped to prevent damage or future settlement. Any damage or misalignment of the existing piping due to construction or settlement shall be repaired by the Contractor at his expense.

C. Structure Excavation:
1. Excavation shall be made to the grades shown on the Drawings and to such widths as will give suitable room for construction of the structures, for bracing and supporting, pumping and draining. The bottom of the excavations shall be rendered firm and dry and in all respects acceptable to the Owner.
2. Excavation shall be accomplished by methods which minimize disturbance of subgrade soils. For structures having multiple bearing levels or adjacent structures at different levels, excavation and foundation construction shall first be accomplished at the lowest levels to prevent undermining foundations and disturbing adjacent bearing soils at higher levels.
3. Excavation equipment shall be satisfactory for carrying out the work in accordance with the Specifications. Earth shall not be plowed, scraped, or dug with machines so near to the finished subgrade as to result in excavation of, or disturbance of material below sub grade.
4. When excavation for foundations has reached final depths, the Owner shall be notified and will inspect conditions. If materials and conditions are not satisfactory to the Owner, the Owner will issue instructions as to the procedures.
5. For structures not pile supported, during final excavation to subgrade level, take precautions required to prevent disturbance of material. Hand excavate the final 6-inches as necessary to obtain a satisfactory undisturbed bottom.

D. Roadway Excavations:
1. Roadway excavation shall consist of excavation for the roadways in conformity with lines, grades, cross sections, and dimensions shown on the Drawings and shall include the excavation of all unsuitable material from the subgrade.
2. The subgrade shall be compacted to a 95 percent maximum density.

E. Unsuitable or Over-Excavation:

1. If any over-excavation occurs through error of the Contractor or for Contractor's convenience, it shall be refilled at the Contractor's expense with concrete, select fill or other material satisfactory to the Owner.
2. If the Contractor fails to properly dewater the excavation or trench, or disturbs the subgrade or otherwise fails or neglects to conduct the excavation work in a manner that provides the surface of the subgrade in proper condition for construction, the Contractor shall remove all disturbed material and replace it with concrete, select fill, or other approved material at his own expense. The condition of the subgrade shall meet with the approval of the Owner before any work is placed thereon.
3. For structures not pile supported, if, in the opinion of the Owner, the material, in its undisturbed natural condition, at or below the grade of the excavation indicated on the Drawings is unsuitable for foundations, or if organic or silty soil extends below excavation depth, it shall be removed to such depth and width as the Owner may direct and be replaced with select fill or other suitable material as directed by the Owner.

F. Where the structure or pipeline is to be placed below the ground water table, well points, cofferdams or other acceptable methods shall be used to permit construction of said structure or pipeline under dry conditions. Dry conditions shall prevail until concrete has reached sufficient strength to withstand earth and hydrostatic loads and until the pipelines are properly jointed, tested and backfilled. In addition, protect excavation from flooding until all walls and floor framing up to and including grade level floors are in place and backfilling has begun. Water level shall be maintained below top of backfill at all times.

G. Pumping of water from excavations shall be done in such a manner to prevent the carrying away of unsolidified concrete materials, and to prevent damage to the existing subgrade.

3.6 SHEETING, SHORING AND BRACING

A. General:
1. Sheeting, shoring and bracing shall be used where necessary to prevent injury to workers, structures, or pipe lines. Jetting for sheeting installation is prohibited.
2. All municipal, county, state and federal ordinances, codes, regulations and laws shall be observed. All trenches shall be shored with the minimal protection of sheeting listed in OSHA Regulations, 29 CFR, Part 1926, Subpart P - Excavations, Trenching and Shoring. The Contractor shall comply with latest revisions of all OSHA regulations for all excavations, sheeting, shoring, and bracing whether they are individually listed here or not.
3. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
4. Unless otherwise shown, specified, or ordered, all materials used for temporary sheeting shall be removed when work is completed. Such removal shall be made in a manner not injurious to the structure or its appearance or to adjacent Work.
5. Provide permanent sheeting as shown. Cut off tops as required, but at least 2-feet below finished grade.
6. The clearances and types of the temporary sheeting, insofar as they affect the character of the finished Work, will be subject to the approval of the Engineer but the Contractor shall be responsible for the adequacy of all sheeting, shoring, bracing and other related Work.
7. Safe and satisfactory installation of the sheeting shall be the entire responsibility of the Contractor.

B. Sheeting Left in Place:
1. Steel sheet piling to be left in place shall be driven straight to the lines and grades shown or directed. Piles shall penetrate into firm materials with secure interlocking throughout the entire length of the pile. Damaged piling having faulty alignment shall be pulled and replaced with new piling.

2. The type of guide structure used and method of driving steel sheet piling to be left in place shall be subject to approval of the Engineer.
3. The Contractor shall cut off piling left in place to the grades shown or ordered by the Engineer and shall remove the cut offs from the site.
4. The Contractor shall thoroughly clean wales, braces and all other items to be embedded in the permanent structure, and shall make provisions that the concrete surrounding the embedded element is sound and free from air pockets or harmful inclusions. The provisions shall include the cutting of holes in the webs and flanges of wale and bracing members, and the welding of steel diaphragm waterstops perpendicular to the centerline of brace ends which are to be embedded.
5. Subsequent to removal of the inside face forms, and when removal of bracing is permitted, steel shall be cut back at least 2 inches inside the wall face and the opening patched with cement mortar. The concrete shall be thoroughly worked beneath wales and braces, around stiffeners and in any other place where voids may be formed.

C. Removal of Sheeting and Bracing:
1. Unless otherwise shown on the Drawings or ordered in writing by the Engineer, all sheeting and bracing shall remain in place. If removal of sheeting and/or bracing is required, removal shall be done so as to not cause damage to the Work. Earth pressure shall be equal on both sides of excavation to ensure no unequal loads on pipe or structure. Use of vibratory extractors is prohibited.
2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until wall and floor framing up to and including grade level floors are in place and concrete has attained sufficient strength to withstand the soil loads.

3.7 BACKFILL AND COMPACTION

A. Fill excavations as promptly as Work permits, but not until completion of the following:
1. Acceptance by the Engineer of all Work within the excavation.
2. Inspection, testing approval, and recording of locations of underground utilities, connections, branches, structures and other facilities.
3. Removal of temporary shoring and bracing, and backfilling of voids with satisfactory materials.
4. Removal of trash and debris.

B. Excavation shall be kept dry during backfilling operations. Backfills around piping and structures shall be brought up evenly on all sides.

C. General fill and select fill materials shall be placed in layers not exceeding 8 inches in thickness, and each layer shall be compacted as specified below.

D. Backfill in pipe trenches which is below other pipes, structures, foundations, or paved areas shall be select fill and shall be placed in horizontal layers not exceeding 8 inches in depth and thoroughly compacted before the next layer is placed. Compaction layers shall be 8 inches up to the pipe spring line and 12 inches thereafter in trenches that are not below other pipes, structures, foundations, or paved areas.

E. Backfill above and adjacent to pipe, and adjacent to buildings and tank walls shall be compacted by light weight equipment, such as "walk behind" vibratory plate compactors. Heavy self-propelled compactors shall not be used until the following criteria are met:
1. A minimum of 18 inches of compacted backfill has been placed above the top of the pipe.
2. Area to be compacted is a minimum distance of 3 pipe diameters away from the adjacent pipe.
3. Area to be compacted is a minimum of 10 feet from building and tank walls and riser pipes.

F. Levels of backfill against concrete walls shall not differ by more than 2 feet on either side of walls unless walls are adequately braced or all floor framing is in place up to and including grade level slabs. Particular care shall be taken to compact structure backfill that will be beneath pipes, roads,

or other surface construction or structures. In addition, wherever a trench passes through structural backfill, the structural backfill shall be placed and compacted to an elevation 12 inches above the top of the pipe before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

G. Backfill in Pipe Trenches:
   1. Pipeline trenches may be backfilled prior to pressure testing the pipe, but no structure shall be constructed over any pipeline until it has been tested.
   2. All pipe larger than 6 inches in diameter shall be placed on existing Sand Stratum 4, Select Fill or granular embedment material. Pipe 6 inches in diameter and smaller shall be placed in granular embedment material unless the trench bottom has been graded to provide uniform and continuous support of the installed pipe.

H. Backfill in Electrical Ductbank Trenches:
   1. Compacted backfill will be required for the full depth of the trench above the electrical ductbank. Where the trench for one ductbank passes beneath the trench for another pipe or ductbank select backfill shall be placed to the level of the bottom of the upper trench.

I. Crushed Stone Placement:
   1. Crushed stone shall be placed where shown on the Contract Drawings.
   2. Crushed stone shall be placed in hand tamped lifts not to exceed 6 inches.

J. Hydro hammers or "jumping jack" hammers shall not be used above pipes until a minimum of 3 feet of backfill has been placed and compacted.

K. Compaction Density Requirements:
   1. Unless otherwise noted, the degree of compaction required for all types of fills shall be 95 percent in accordance with ASTM D 698. Material shall be moistened or aerated as necessary to provide the moisture content that will facilitate obtaining the specified compaction. Moisture content shall be withing 2 percent of optimum moisture content per laboratory testing.
   2. Drainage stone shall be compacted with a vibratory plate compactor or vibratory rolling compactor. Three complete passes shall be made on each 8-inch thick loose layer of stone. Each pass shall overlap the adjacent previously compacted area a minimum of 20 percent. Density requirement for the drainage stone will be considered satisfactory upon completion of compaction.
   3. Owner’s laboratory will perform tests necessary to provide data for selection and control of fill material placement and water content.
   4. Owner’s laboratory will perform field density tests to insure that the specified density is being obtained during each day of compaction work. Number of tests will be determined by the Engineer.
   5. If the tests indicate unsatisfactory compaction, the Contractor shall provide the additional compaction necessary to obtain the specified degree of compaction. All additional compaction work shall be performed by the Contractor at no additional cost to the Owner until the specified compaction is obtained. This Work shall include complete removal of unacceptable fill areas and replacement and recompaction until acceptable fill is provided, as determined by the Engineer.

L. The Contractor shall repair any damage, at no additional cost to the Owner, after-settlement that occurs. They shall make all repairs and replacements necessary within 30 days after notice from the Engineer.

3.8 GRADING

A. Uniformly grade areas within limits of the Work, including adjacent transition areas. Smooth subgrade surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Turfed Areas: Finish areas to receive topsoil to within not more than 1 inch above or below the required subgrade elevations.

C. Walks: Shape surface of areas under walks to the line, grade and cross-section shown, with finish surface not more than 1 inch above or below the required subgrade elevation.

D. Pavements: Shape surface of areas under pavements to the line, grade and cross-section shown, with finish surface not more than 1/2 inch above or below the required subgrade elevation.

E. Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/4 inch when tested with a 10-foot straightedge.

F. Compaction: After grading, compact subgrade surfaces to the depth and percentage of maximum density required.

3.9 REMOVAL OF UNSUITABLE MATERIALS

A. The Contractor shall remove and dispose off site all unsuitable organic and/or inorganic materials. Within thirty (30) consecutive days after Notice to Proceed, the Contractor shall submit to the Owner for review all required permits and a list of disposal sites for the unsuitable materials. If the disposal site is located on private property the submittal shall also include written permission from the Owner of record.
B. All unsuitable materials shall be disposed of in locations and under conditions that comply with Federal, State and local laws and regulations.
C. The Contractor shall obtain an off-site disposal area prior to beginning demolitions or excavation operations.
D. All unsuitable materials shall be hauled in trucks of sufficient capacity and tight construction to prevent spillage. Trucks shall be covered to prevent the escape of odors and the propagation of dust.
E. When all unsuitable material disposal operations are completed, the Contractor shall leave the disposal site in a condition acceptable to the Owner of the disposal site.
F. The Contractor shall not dump soil onto those areas designated by the Owner as wetlands or waterways. Each Contractor shall not stockpile or store spoil, materials, tools or equipment on wetlands. Stockpiling of unsuitable organic material is not permitted on site.

3.10 RESTORING AND RESURFACING EXISTING ROADWAYS AND FACILITIES

A. The Contractor shall place 1-1/2 inches of temporary bituminous pavement immediately after backfilling excavations in paved roadways. They shall maintain, in good and safe condition during progress of the entire Work, the surface of the paved area over the excavation, and shall promptly fill all depressions over and adjacent to the excavation caused by settlement of backfill. Immediately prior to constructing the permanent paving and base the Contractor shall remove and dispose of temporary pavement. Permanent replacement pavement shall conform to the requirements of Section 02500.

B. Pavement, gutters, curbs, walks, driveways and roadways disturbed or damaged by the Contractor's operations shall be restored or replaced by him to original or better condition.

C. After all other work has been completed in each area, place and grade topsoil to a depth of not less than 6-inches.

3.11 DRAINAGE AND DEWATERING

A. Drainage and Dewatering:

1. Contractor shall provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, therein is inspected by the Engineer and backfill operations have been completed and approved.
    a. The different working areas on the Site shall be kept free of surface water at all times. Contractor shall install drainage ditches and dikes and shall perform all pumping and other Work necessary to divert or remove rainfall and all other accumulations of surface water from the excavations and fill areas. The diversion and removal of surface water shall be performed in a manner that will prevent the accumulation of water behind temporary structures or at any other locations within the construction area where it may be detrimental.
    b. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the water downstream of the point of discharge, shall not be directly discharged. Such waters shall be diverted through a settling basin or filter before being discharged.
    c. Contractor will be held responsible for the condition of any pipe, conduit or channel used for drainage purposes and all such pipes, conduits or channels shall be left clean and free of sediment.
    d. Remove water from excavations as fast as it collects.
2. Contractor shall be responsible for obtaining all applicable federal, state, and/or local permits associated with dewatering operations pursuant to 6 NYCRR Parts 601 and/or 602, Section 404 of the Clean Water Act, Section 10 of the Rivers and Harbors Act, and any applicable local law. Full approval of all applicable permits is required before any dewatering operation is to begin.
    a. Any proposed dewatering operation involving well points must be carried out only by licensed well drillers in accordance with Section 15-1525 of the Environmental Conservation Law.
    b. Contractor shall be responsible for furnishing all applicable application materials including the design details of the proposed dewatering system.
3. The Contractor is responsible for notifying the New York State Department of Environmental Conservation prior to the proposed starting date of the dewatering operation, providing the following details in full. This notification is in addition to the requirements to obtain the permit or permits from the municipality or other appropriate agencies.
    a. The name of the licensed well driller,
    b. The details of the dewatering system to be installed including size, the number, and the spacing of the well points, the pump capacity, the pumping rate, and the expected volume of water to be withdrawn,
    c. The amount of water table drawdown,
    d. The final deposition of the water,
    e. The expected duration of the operation.
4. If any unforeseen constriction arises, the contractor must notify the New York State Department of Environmental Conservation as soon as possible, that dewatering under such emergency circumstances has been started.
5. Notification will be made to the following:
    a. New York State Department of Environmental Conservation
       Regional Permit Administrator
       50 Circle Road
       Stony Brook, NY 11790
6. Contractor shall provide, install and operate sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, etc., necessary to depress and maintain the ground water level below the base of the excavations during all stages of construction operations. The ground water table shall be lowered in advance of excavation, for a sufficient period of time so as to permit dewatering of fine grain soils, and maintained two feet below the lowest subgrade

excavation made until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural ground water. The system shall be operated on a 24-hour basis and standby pumping facilities and personnel shall be provided to maintain the continued effectiveness of the system. If, in the opinion of the Engineer, the water levels are not being lowered or maintained as required by these Specifications, Contractor shall install additional or alternate dewatering devices as necessary, at no additional cost to the Owner.

a. Elements of the system shall be located so as to allow a continuous dewatering operation without interfering with the construction of the permanent Work. Where portions of the dewatering system are located in the area of permanent construction, Contractor shall submit details of the methods he proposes to construct the permanent Work in this location for the approval of the Engineer. Controls of ground water shall continue until the permanent construction provides sufficient dead load to withstand the hydrostatic uplift of the normal ground water, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, and until all waterproofing Work has been completed. Dispose of all water removed from the excavation in such a manner so as not to endanger any portion of the Work under construction or completed. Convey water from the excavations in a closed conduit. Before discontinuing dewatering operations or permanently permitting the rise of the ground water level, computations shall be made to show that any structure affected by the water level rise is protected by backfill or other means to sustain uplift. Use a safety factor of 1.25 when making these computations.
b. Dewatering operations shall not be discontinued without the prior authorization of the Engineer.
c. Design of dewatering system, including both drawings and calculations, shall be performed by a Registered Professional Engineer in the State of New York and shall be employed by Contractor. Dewatering system shall be designed so as to avoid settlement or damage to existing structures and utilities.
d. The entire dewatering operation and the apparatus connected therewith must, at all reasonable hours, be open to inspection, and tested by an accredited representative of the New York State Department of Environmental Conservation.

B. Disposal of Water Removed by Dewatering System:
1. Contractor's Dewatering System shall discharge to location directed by NASSAU COUNTY, in accordance with State and Federal regulations.
2. Dispose of all water removed from the excavation in such a manner as not to endanger public health, property, or any portion of the Work under construction or completed.
3. Dispose of water in such a manner as to cause no inconvenience to Owner, Engineer, or others involved in Work about the Site.
4. Convey water from the construction Site in a closed conduit. Do not use trench excavations as temporary drainage ditches.

+ + END OF SECTION + +

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SECTION 02228

CONSTRUCTION NOISE AND VIBRATION CONTROL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. The work to be done under this Section includes, but is not limited to, conducting all activities on the project in such a manner that damage is prevented to adjacent pipes, structures, property and work, and such that construction noise, ground vibrations and ground and structure displacements are consistently maintained below the maximum levels specified in this Section.
   2. Notifying the Engineer prior to conducting any noise and vibration producing construction activity, and conducting appropriate monitoring at nearby structures in accordance with the plan prepared by the Contractor's third party specialist and approved by the Engineer.
   3. The Contractor's third party specialist shall provide, install, and set up engineering seismographs and sound level meters adjacent to or on structures, utilities or other potentially affected areas, as appropriate.
   4. Protecting vibration and sound level monitoring equipment, and other monitoring equipment that exists or is installed as required by the Contract Documents.
   5. Submitting noise and vibration monitoring reports.
   6. Resolution of complaints, damage and exceedances of threshold and limit value criteria.

B. Related Sections:
   1. Section 02050, Demolition, Removals, and Modifications
   2. Section 02200, Earthwork

1.2 REFERENCES

A. All construction noise and vibration control work shall be in accordance with:
   1. FTA – Trans Noise and Vibration Impact Assessment
   2. ANSI S1.4 & S1.43 Specification for Sound Level Meters
   3. The State of New York

1.3 JOB CONDITIONS

A. The Contractor shall engage a qualified, third party specialist to install and monitor engineering seismographs adjacent to or on adjacent structures or utilities, for the purpose of monitoring and ensuring compliance with the noise and vibration specified herein. The Contractor's third party specialist may also monitor related geotechnical instrumentation such as observation wells, piezometers and inclinometers.

B. Vibration and sound level monitoring shall be performed by the Contractor's third party specialist using personnel experienced in the correct placement and monitoring of engineering seismographs and sound level meters.

C. Vibration and noise monitoring shall be performed continuously during all demolition and construction activities at the site.

1.4 SUBMITTALS

A. Submit qualifications for the third party specialist whose services have been selected by the

Contractor for performing the noise and vibration monitoring work demonstrating at least 5 similar assignments completed successfully during the last 5 years.

B. Before beginning work that may cause noise or vibrations, submit a Construction Noise and Vibration Monitoring and Control Plan including:
   1. Instrument specifications and calibrations.
   2. Table of expected noise and vibration producing activities including: description of activity, location, and anticipated dates and times of activities.
   3. Table of structures, utilities, levees and other noise and/or vibration sensitive receptors (including identification of historic structures and sites) that may be impacted by noise and vibration including: structure description, street address, name and address of Owner, and names of occupants.
   4. Proposed monitoring locations.
   5. A Construction Vibration Assessment performed in accordance with the guidance in Chapter 12 of the FTA Transit Noise and Vibration Impact Assessment Manual (April 1995) for construction activities.
   6. A Construction Noise Assessment performed in accordance with the guidance in Chapter 12 of the FTA Transit Noise and Vibration Impact Assessment Manual (April 1995) for construction activities.
   7. Preliminary evaluation of structure susceptibility to vibration induced damage.
   8. Monitoring program procedure including reporting procedures.
   9. Noise and Vibration Mitigation Plan (including damage prevention).
   10. Sample Noise and Vibration Data Report.
   11. Plan to deal with and resolve complaints.

C. Before beginning work that may cause noise or vibrations, initiate a Construction Noise and Vibration Monitoring and Control Program. The Contractor shall perform the following actions:
   1. Within 2 working days of receipt of each seismograph and noise meter at the site, submit copy of specifications, manual, factory calibration and manufacturer's test equipment certification.
   2. Submit background noise and vibration data reports for each building, utility, levee or other sensitive receptor in accordance with Table 2 of this Section.
   3. Submit weekly Noise and Vibration Data Reports, within 3 days of the end of each week.
   4. Submit Noise and Vibration Data Reports within 1 working day of requests by the Engineer in response to complaints by adjacent property owners.

D. Submit pre-condition surveys of potentially impacted properties, at least two weeks before the start of vibration producing activities.

E. Submit post-condition surveys of potentially impacted properties, no later than four weeks after the completion of vibration producing activities.

F. The Engineer shall be notified immediately if any noise or vibration readings exceed the threshold or limiting values specified herein.

PART 2 – PRODUCTS

2.1 EQUIPMENT

A. Noise Meters: Provide and operate Type 1 or Type 2 sound level meters consistent with ANSI and ASTM requirements for monitoring noise levels from construction activities and equipment:
   1. Noise level range: 40 to 120 db, or mid-scale.
   2. Metric: Leq, 1-hour average.
   3. A-weighted frequency response.
   4. Response time: slow setting for continuous or intermittent noise; fast setting for impulsive noise (a momentary sound such as a horn).
   5. Windscreen: place factory-supplied windscreen over microphone during all measurement periods.
   6. Position: the meter microphone should be positioned at a height of 4 feet above ground level and at least 10 feet away from a reflecting surface (such as a wall). The microphone can be handheld or tripod mounted.
   7. Data shall be collected either by manually reading and recording noise levels or by storing and downloading the data remotely depending on the capabilities of the meters used. The date, time, monitoring location and nature of construction activities shall be reported with the data.
   8. Field calibration: Noise meters shall be field calibrated before and after each measurement, or at least once per hour, whichever is more frequent using a calibrator specified for use with the meter and the manufacturer's instructions for calibration.

B. Seismographs: Provide portable seismographs for monitoring the velocities of ground vibrations resulting from construction activities, with the following minimum features:
   1. Seismic range: 0.01 to 8 inches per second with an accuracy of 5% and no more than a 3 db roll off at the low frequency end.
   2. Flat frequency response: 2 to 200 Hertz.
   3. Three-component sensor.
   4. Fourth channel for air blast monitoring.
   5. Two power sources: Internal rechargeable battery and charger and 115 volts AC. Battery must be capable of supplying power to monitor vibrations continuously for at least 24 hours.
   6. Direct writing to printer and to either 3.5-inch magnetic disk or CD.
   7. Instruments must be capable of producing strip chart recordings of readings on site within one hour of obtaining the readings. Provide computer software to perform frequency analyses of data obtained on magnetic disks.
   8. Continuous mode and histogram mode capabilities for recording vibrations. 9. Histogram mode must include frequencies of each peak vibration.
   9. Capability of downloading data remotely via telephone modem.

C. Factory calibration: Provide factory calibrations for each instrument. Perform seismograph calibrations using a shake table and a reference sensor traceable to the national institute of standards and technology. Perform noise meter calibrations using a calibrator traceable to the national institute of standards and technology. Recalibrate the instruments at least once every 12 months.

PART 3 – EXECUTION

3.1 GENERAL

A. The Contractor shall prepare a Construction Noise and Vibration Monitoring and Control Plan. Preconstruction components of the Plan shall be completed prior to construction and submitted to the Engineer for approval at least two weeks prior to the onset of construction.
   1. All noise and vibration monitoring instruments shall be installed in the presence of the Engineer. The Contractor shall allow access to the work area at all times for the purpose of observing instrumentation and obtaining data. The Contractor shall determine the elevation

and location of all instrumentation a minimum of one week prior to excavation or demolition.

2. The Contractor shall be responsible for any and all damage incurred to utilities during instrumentation installation.
3. The Contractor shall protect and maintain instrumentation until the end of the Contract. Any instrumentation damaged or otherwise rendered non-functional shall be repaired or replaced with a new installation within five working days at no additional cost to the Owner. Repair or replacement work shall conform to the requirements specified herein for the respective type of geotechnical instrumentation.
4. The Contractor shall provide and maintain well-delineated protection devices at the surface on all instrumentation.
5. The Contractor shall monitor construction activity noise for two one-hour periods each week when Contractor's activities are most noise intensive. The Monitoring Plan shall identify the one-hour daytime and one-hour nighttime monitoring periods to be used throughout the monitoring program.
6. The Contractor shall monitor construction activity noise at actual or representative sensitive receptor locations. Sensitive receptor locations that are adjacent to one another and would be expected to experience equivalent exposure to construction noise may be clustered by selecting a representative monitoring location. The monitoring locations shall have an unobstructed line of sight to the construction site. The selected monitoring locations and rationale for selection shall be identified in the Monitoring Plan and shall be used throughout the monitoring program.
7. When no construction activity occurs within 1000 feet of a monitoring location during any single week, no monitoring needs to be performed at that location during that week. The Contractor shall provide an explanation of that circumstance in the Noise and Vibration Data Report for that week.

B. The Contractor shall execute a Construction Noise and Vibration Monitoring and Control Program. The Program shall be performed consistent with the requirements and conditions specified in the Construction Noise and Vibration Monitoring and Control Plan.

C. The Contractor shall use every effort and every means possible to minimize noise caused by its operations. The Contractor shall provide working machinery and equipment designed to operate with the least possible noise, including the use of shields, soundproof housings, enclosures, or other physical barriers to restrict the transmission of noise. Compressors shall be equipped with silencers or mufflers on intake and exhaust lines. Wherever practicable, electricity shall be used for power to reduce noise. Where required by agencies having jurisdiction, certain noise producing work may have to be performed during other than regular working hours or at specified periods only.

D. If the need arises, the Contractor will be required to assist the Engineer and the Owner with community coordination activities relative to public noise exposure.

3.2 GENERAL NOISE LEVEL RESTRICTIONS

A. Contractor shall comply with local noise ordinances.

B. As part of the Construction Noise and Vibration Monitoring and Control Plan, the Contractor shall prepare a Construction Noise Assessment in accordance with the guidance in Chapter 12 of the FTA Transit Noise and Vibration Impact Assessment Manual for construction activities. The Contractor must determine the potential for construction noise impacts on noise sensitive receptors, develop a mitigation plan to prevent impacts to the maximum extent practicable, and develop a Monitoring Plan.

C. Contractor assumes all responsibility and liability for any noise impacts on sensitive receptors.

D. Ambient noise measurements will be taken and mitigation measures identified and utilized to ensure compliance with local noise ordinances.

E. Noise monitoring shall not be conducted during precipitation events or in winds greater than 12 miles per hour.

F. If a Maximum Acceptable Construction Noise Level is reached:
   1. Immediately notify the Engineer.
   2. Meet with the Engineer to discuss response action(s).
   3. Submit an up-to-date report within 24 hours for all instruments for which the Maximum Level was reached, as well as on any other instruments requested by the Engineer.

G. In addition to the above steps, if a Maximum Acceptable Construction Noise Level is reached, initiate the following response actions, as directed by the Engineer.
   1. Increase instrument monitoring frequencies.
   2. Install and monitor additional instruments.
   3. Modify construction procedures.
   4. Implement Mitigation Measures specified in Article 3.10 of this Section or as identified in the Construction Noise and Vibration Monitoring and Control Plan, so that the Maximum Level is not exceeded.

H. If the Maximum Level is reached, the Contractor may be directed to suspend activities in the affected area with the exception of those actions necessary to avoid exceeding the Maximum Level.

I. If complaints about noise are received, the Contractor shall promptly conduct additional monitoring at additional times, locations and frequencies, as directed by Engineer, and immediately inform Engineer of the results of such monitoring, at no additional cost to the Owner.

3.3 SPECIFIC NOISE LEVEL RESTRICTIONS

A. Noise levels at the construction site limits shall not exceed values provided in local ordinances.

B. The Contractor shall ensure that appropriate measures will be in place during construction to protect the sensitive receptors from noise impacts to the maximum extent practicable. These measures shall be identified within the Noise and Vibration Mitigation Plan.

3.4 GROUND VIBRATION LIMITS

A. As part of the Construction Noise and Vibration Monitoring and Control Plan, the Contractor shall prepare a Construction Vibration Assessment in accordance with the guidance in Chapter 12 of the FTA Transit Noise and Vibration Impact Assessment Manual for construction activities. The Contractor must determine the potential for construction vibration impacts on vibration sensitive receptors, develop a mitigation plan to prevent impacts to the maximum extent practicable, and monitor construction activity vibration as needed.

B. Contractor assumes all responsibility and liability for any vibration damage to surrounding buildings and structures as a result of the Contractor's activities if deemed the result of the fault of the Contractor.

C. Table 02228-A, located after "End of Section" designation, indicates Threshold and Limiting Values for seismographs. These values are defined collectively as Response Values. The actions associated with these Response Values are defined. Response Values are subject to adjustment by

the Engineer as indicated by prevailing conditions or circumstances.

D. If a Threshold Value is reached:
   1. Immediately notify the Engineer.
   2. Meet with the Engineer to discuss response action(s).
   3. Submit an up to date report within 24 hours for all instruments for which the Threshold Value was reached, as well as on any other instruments requested by the Engineer. Continue to submit daily reports until all instrument readings fall below the specified Threshold Values, or unless otherwise directed by the Engineer.

E. In addition to the above steps, if a Threshold Value is reached, initiate the following response actions, as directed by the Engineer.
   1. Increase instrument monitoring frequencies.
   2. Install and monitor additional instruments.
   3. Modify construction procedures.
   4. Implement Mitigation Measures as specified in Contract Documents and this Section or as identified in the approved Construction Noise and Vibration Monitoring and Control Plan, so that the Limiting Value is not exceeded.

F. If a Limiting Value is reached:
   1. If limiting values of vibration are exceeded, all work by the Contractor in the vicinity of the exceedance shall stop until a meeting takes place between the Contractor and the Engineer to assess the cause of the exceedance.
   2. Immediately notify the Engineer.
   3. Meet with the Engineer to discuss response action(s).
   4. Submit an up-to-date report within 24 hours for all instruments for which the Limiting Value was reached, as well as on any other instruments requested by the Engineer. Continue to submit daily reports until all instrument readings fall below the specified Threshold Values, or unless otherwise directed by the Engineer.
   5. A submittal shall be prepared and submitted to the Engineer indicating what activity caused the exceedance and what steps the Contractor will take to prevent further exceedances of the limits. No work in the vicinity of the exceedance shall be restarted until the submittal is reviewed and approved by the Engineer.

G. Implement Mitigation Measures as specified in Contract Documents or as identified in the approved Construction Noise and Vibration Monitoring and Control Plan, so that the Limiting Value is not exceeded.

H. If complaints about noise or vibrations are received, the Contractor shall promptly conduct additional monitoring at additional times, locations and frequencies, as directed by Engineer, and immediately inform Engineer of the results of such monitoring, at no additional cost to Owner.

3.5 GROUND BORNE NOISE AND VIBRATION LEVEL RESTRICTIONS

A. The Contractor shall ensure that appropriate measures will be in place during construction to protect the sensitive receptors and historic structures from damage and foundation cracking to the maximum extent practicable. These measures shall be identified within the approved Construction Noise and Vibration Mitigation Plan.

3.6 SEISMOGRAPH INSTALLATON

A. Install seismographs in accordance with Manufacturer's installation instructions.

B. Firmly mount seismographs on the surface slab of concrete or asphalt, firmly set them in undisturbed soil, or rigidly attach them to the structure of buildings.

3.7 PROTECTION OF INSTRUMENTS

A. Protect all instruments and appurtenant fixtures, leads, connections, and other components of instrumentation systems from damage due to construction operations, weather, traffic, and vandalism.

B. If an instrument is damaged, repair or replace the damaged instrument at no additional cost to the Owner, including damage resulting from Contractor. Contractor's actions to instruments installed by others. The Engineer will be the sole judge of whether repair or replacement is required. The Engineer may impose a work stoppage in the vicinity of the damaged instrument until it is again operational, at no additional cost to the Owner.

3.8 DATA COLLECTION

A. Comply with the schedule in Table 02228-2B, located after ""End of Section"" designation.

3.9 MITIGATION MEASURES

A. As part of the Construction Noise and Vibration Monitoring and Control Plan, the Contractor shall prepare a Noise and Vibration Mitigation Plan. The Plan shall identify potential noise and vibration impacts during construction activities, and the measures the Contractor will use to minimize those impacts.

B. Measures to minimize construction noise and vibration impacts must be evaluated for effectiveness by the Contractor. Such measures may include, but are not limited to:
   1. Minimize the use of other loud construction equipment during nighttime hours.
   2. Sequence operations, combining noisy events to occur at the same time on order to reduce the total length of the noise generating activity, and avoid nighttime construction.
   3. Use alternative construction methods such as: drill pile instead of impact pile driving, using quieted equipment, and alternative demolition techniques.
   4. Use shields, impervious fences or other physical barriers to inhibit the transmission of noise.
   5. Use sound retardant housings or enclosures around noise producing equipment.
   6. Use effective intake and exhaust mufflers on internal combustion engines and compressors.
   7. Use electric instead of diesel-powered equipment.
   8. Use covered hoppers, storage bins, and chutes with sound deadening material.
   9. Use hydraulic tools instead of pneumatic impact tools.
   10. Minimize use of air or gasoline driven saws.
   11. Conduct truck loading, unloading, and hauling operations so that noise and vibration are minimized.
   12. Place operation limitations on machines and trucks.
   13. Site stationary equipment to minimize noise and vibration impact on the community.
   14. Plan noisier operations during times of highest ambient noise levels.
   15. Keep noise levels relatively uniform, avoid peaks and impulse noises.
   16. Turn off idling equipment.
   17. Phase in startup and shutdown of equipment.

3.10 NOISE AND VIBRATION COMPLAINT RESOLUTION

A. As part of the Construction Noise and Vibration Monitoring and Control Plan, the Contractor shall prepare and implement a plan for responding to and resolving noise and vibration complaints that may arise during construction activities.

3.11 SCHEDULES

A. Schedules, listed below, following the "End of Section" designation, are part of this Specification Section:
   1. Table 02228-A, Response Values
   2. Table 02228-B, Monitoring Schedule

++ END OF SECTION ++

TABLE 02228-A, RESPONSE VALUES

INSTRUMENT	THRESHOLD VALUE	LIMITING VALUE
Seismographs at buildings: Continuous or Steady State Vibration (see Note 1)	Peak Particle Velocity: 0.3 in/sec for frequencies less than 30 Hz 0.4 in/sec for frequencies greater than 60 Hz	Peak Particle Velocity: 0.5 in/sec for frequencies less than 30 Hz 0.8 in/sec for frequencies greater than 60 Hz
Seismographs at buildings: Transient or Impact Vibration (see Note 2)	Peak Particle Velocity: 0.75 in/sec for frequencies less than 60 Hz 1 in/sec for frequencies greater than 90 Hz	Peak Particle Velocity: 1.5 in/sec for frequencies less than 60 Hz 2 in/sec for frequencies greater than 90 Hz
Special Response Values for Instruments at Historic Buildings	One-half the velocities listed above	One-half the velocities listed above
Special Response Values for Instruments at Buried Pipeline Utilities	Peak Particle Velocity = 2 in/sec	Peak Particle Velocity = 3 in/sec
Special Response Values for Instruments at Levees	Peak Particle Velocity = 1.5 in/sec	Peak Particle Velocity = 2 in/sec

Notes:
1. Response Values for Continuous or Steady State Vibrations apply to vibrations such as vibratory pile drivers, jack hammers, reciprocating pavement breakers, compactors, large pumps and compressors, bulldozers, trucks, cranes, and other large machinery. Use linear interpolation for frequencies between 30 Hz and 60 Hz.
2. Response Values for Transient or Impact Vibrations apply to vibrations such as blasting, drop chisels, clam shell buckets, impact pile drivers, wrecking balls, building demolition, gravity drop ground compactors and gravity drop pavement breakers. Use linear interpolation for frequencies between 60 Hz and 90 Hz.

TABLE 02228-B, MONITORING SCHEDULE

INSTRUMENT	SCHEDULE
Noise meters	Obtain noise measurements during the designated one-hour daytime monitoring period, in the Leq metric, and the designated one-hour nighttime monitoring period one week before construction begins at the selected noise monitoring locations to establish background noise levels. Obtain, obtain noise measurements during the designated one-hour daytime monitoring period, in the Leq metric, and the designated one-hour nighttime monitoring period each week during construction activities at the selected noise monitoring locations. Submit data reports weekly.
Seismographs	Continuously, in histogram mode (5-minute intervals), for one week before construction begins, to obtain background vibration levels. At the start of vibration-inducing construction activities, determine peak particle velocity and corresponding frequencies produced by single hammer blows or blasts or other vibration-producing activities to establish the maximum energy which can be used without surpassing acceptable vibration levels in nearby structures. Perform separate tests for each building. Continuously in histogram mode (5-minute intervals) during vibration-producing construction activities within 300 feet of seismograph location. Submit reports weekly.

SECTION 02272

SOIL EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies requirements for the construction and maintenance of various temporary soil erosion and sediment control measures, including relocation as required for staged construction.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM) ASTM C 33 Specification for Concrete Aggregates

1.03 REQUIREMENTS

A. Environmental Requirements
   1. Apply dust retardants other than water only when wind velocity is less than 5 mph and drift hazard is negligible.
   2. Conform to "Seeding Calendar Limitations" of the Section entitled "SEEDING".
   3. Use Dust Retardant or other approved methods for temporary surface stabilization of short duration where establishing grass by seeding is not practical.

B. Construction Requirements
   1. The Contractor shall employ soil erosion and sedimentation control measures during the duration of the contract to control erosion and minimize the sedimentation of water courses on the construction site.
   2. The Contract Drawings do not include borrow pits or storage areas that the Contractor utilizes or establishes outside of the site in order to perform the Work. If the land disturbance for this Work is five thousand square feet (5,000 SF) or greater, the Contractor shall provide the Engineer with documentation that a soil erosion and sediment control plan has been approved for this Work by the appropriate Soil Conservation District of the New York State Department of Environmental Conversation.
   3. The Contractor shall incorporate all permanent pollution control features into the project at the earliest practicable time. Temporary soil erosion and sediment control measures shall be coordinated with the permanent pollution control features and with the construction of pavement, drainage facilities such as pipes, culverts, headwalls, channels, ditches, etc., to the maximum extent practical to assure economical, effective and continuous erosion control throughout the duration of the Contract, as outlined in the approved progress schedule.

4. Prior to all grubbing operations, soil erosion and sediment control measures shall be installed. When unstabilized areas caused by site development, grading, or other earth disturbing activities exist beyond 14 calendar days, the areas disturbed shall be seeded and mulched. These requirements pertain to perimeter controls, berms, dams, swales, ditches and slopes. Upon completion of the grading or construction, disturbed areas shall be permanently stabilized in accordance with the Contract Drawings within 7 calendar days.
5. When excavation or embankment construction reaches the finished subgrade, those areas on which paving is to be placed are exempt from the above stabilization requirements. Roadways and haul roads actively being used for daily conveyance of equipment as well as areas between temporary berms, except median areas, are also exempt unless otherwise shown on the Contract Drawings.
7. The turbid discharge from dewatering construction activities shall be contained in a dewatering basin in order to control sediment and provide filtration of water prior to it being released into adjacent streams or other watercourses.
8. Soil being stockpiled shall be placed in well-drained areas no closer than 50 feet from streams, wetlands, floodplains and other watercourses, unless otherwise directed by the Engineer. The stockpiles shall be seeded and mulched in accordance with the Contract Drawings. Temporary soil erosion and sediment controls shall be provided around the stockpiles until such time as vegetation is established on the piles.
9. Temporary soil erosion and sediment control measures shall be used to correct conditions that develop during construction.
10. In the event that temporary soil erosion and sediment control measures are required due to the Contractor's failure, for any reason, to install or maintain soil erosion and sediment controls, either as part of the work or as directed by the Engineer, such Work shall be performed by the Contractor at no additional cost to the Authority.
11. If the Contractor is not in compliance with soil erosion and sediment control provisions, corrective actions shall be taken immediately. The Engineer may suspend the Work, wholly or in part, until such time as the Contractor is fully in compliance. All corrective and remedial work required to bring the Contractor into compliance shall be performed at no additional cost to the Authority.
12. Temporary soil erosion and sediment control measures shall be removed when necessary to allow for the installation of permanent control features or as permanent controls become functional. Before issuance of a Certificate of Final Completion, all items used for temporary soil erosion and sediment control shall be removed unless otherwise shown on the Contract Drawings.

1.04 QUALITY ASSURANCE

A. Progress Schedule
   1. The Contractor shall prepare a progress schedule for the Engineer's approval in accordance with Division 1 of the Specifications.
   2. The progress schedule shall clearly outline the intended maintenance of traffic, the locations where temporary and permanent soil erosion and sediment control

measures shall be installed, and such other information as required. The progress schedule shall give special consideration to sensitive areas such as wetlands, waterways, etc. Appropriate staging and seasonal constraints shall be used to maximize the effectiveness of the soil erosion and sediment controls. The progress schedule shall also indicate when Work is restricted in these sensitive areas as outlined in permits issued by regulatory agencies.

B. Soil Erosion and Sediment Control Manager
   1. The Contractor shall assign to the project a supervisory-level employee to serve in the capacity of Soil Erosion and Sediment Control Manager. This employee shall be thoroughly experienced in all aspects of soil erosion and sediment control and construction. The Contractor shall submit the name and experience of this employee to the Engineer for approval at least 10 working days prior to commencing any Work on the project. Replacement of the Soil Erosion and Sediment Control Manager during the Contract shall be made only after approval of a written request for such replacement.
   2. The Soil Erosion and Sediment Control Manager shall implement approved soil erosion and sediment control schedules and methods of operations. He shall coordinate his operations with the Engineer and shall oversee and supervise all aspects of soil erosion and sediment control work for the project. He will attend all soil erosion and sediment control meetings during the Contract.

1.05 SUBMITTALS

A. Submit catalog cuts for the following:
   1. Geotextiles
   2. Pipe for Slope Drains
   3. Topsoil Stabilization Matting
   4. Dust Retardant

B. Submitcertificatefromgeotextilemanufacturersthatgeotextilescomplywiththe requirements specified in this Section.

C. Submit design computations for sizing of Dewatering Basins prepared by a Professional Engineer, licensed in the State in which the Work will be performed.

E. Submit a Progress Schedule reflecting the requirements of Section 1.04 A.

F. Submit name and applicable experience of Soil Erosion and Sediment Control Manager in accordance with Section 1.04B.

G. Submit alternate methods for stabilizing disturbed areas when seeding calendar limitations apply.

H. Submit documentation of approval of soil erosion and sediment control plan for offsite land disturbance greater than 5000 square feet.

1.06 DELIVERY, HANDLING AND STORAGE

A. Protect materials against damage prior to installation.

1.07 SPARE MATERIALS

A. During construction, the Contractor shall have on hand sufficient spare materials and appurtenances as are necessary to repair damage to permanent and temporary installations.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Geotextiles shall conform to the Section entitled "Geotextiles". Unless otherwise shown on the Contract Drawings, geotextiles shall have a maximum Apparent Opening Size of 0.6 mm. and minimum permeability of 1 x 10-3 cm/sec.
   1. Silt Fences and Inlet Filter Sediment Control shall be "Self Supported".
   2. Geotextiles for other Soil Erosion and Sedimentation Control items shall be "Erosion Control - Class A".

B. Wood stakes, posts and boards shall be solid, reasonably knot-free lumber conforming to the nominal size specified on the Contract Drawings.

C. Hay bales shall consist of timothy, red top or native grasses securely bound with wire or baling twine. The twine shall be an ultra-violet light stabilized polypropylene which has a knot strength of 170 pounds and straight break strength of 300 pounds.

D. Riprap shall be broken stone (argillite, calcite, dolomite, gneiss, granite, quartzite, traprock). Unless otherwise shown on the Contract Drawings, riprap shall have a designated median stone (D50) size in the range of 6 to 9 inches maximum dimension, weighing not more than 150 pounds, with at least 90% weighing more than 25 pounds but not more than 40% exceeding 100 pounds, having the following characteristics:

Characteristic	Max. %
Weathered decomposed stone	5
Other than that classification approved	5
Absorption in cold water	1.8
Sodium sulfate soundness, loss by weight	10

E. Coarse aggregate shall be broken stone or washed crushed gravel meeting the specification for rip rap except for size and weight requirements. Size and gradation shall be as shown on the Contract Drawings.

F. Welded wire fabric shall conform to AASHTO M55 flat sheets or rolls.

G. Pipe for temporary slope drains shall be minimum 8-inch diameter of type shown on the Contract Drawings.

H. Seed and mulch shall be as specified in the Section entitled "SEEDING".

I. Topsoil Stabilization Matting: Topsoil stabilization matting shall be one of the following:
   1. Excelsior mat shall be wood excelsior, 48 + 1 inch in width and weighing 0.8 pounds per square yard, + 5 percent. The excelsior material shall be covered with a netting to facilitate handling and to increase strength and shall be biodegradable.
   2. Jute mat shall be cloth of a uniform plain weave of undyed and unbleached single jute yarn, 48 + 1 inch width and weighing an average of 1.2 pounds per linear yard of cloth with a tolerance of + 5 percent, with approximately seventy-eight warp ends per width of cloth and forty-one weft ends per linear yard of cloth. The yarn shall be of a loosely twisted construction having an average twist of not less than 1.6 turns per inch and shall not vary in thickness by more than one half its normal diameter.

J. Dust Retardant
   1. "Coherex" as manufactured by Golden Bear Division of the Witco Corporation, Chandler, AZ 85244.
   2. "Soil-Sement" as manufactured by Midwest Industrial Supply, Inc., Canton, OH, 44711.
   3. "Soil Seal Concentrate" as manufactured by Soil Seal Corporation, Los Angeles, CA, 90017.
   4. Or approved equal.

K. Calcium Chloride shall be Grade 2, in the form of loose dry granules or flakes, and shall be fine enough to feed through commonly used spreaders at the specified rates.

2.02 CONSTRUCTION FEATURES

A. Silt Fence
   1. Silt fence shall consist of geotextile whose width shall be at least 3 feet to provide for a 2 foot high fence after 1 foot of fabric is buried in the existing soil. Heavy duty silt fence shall consist of geotextile whose width shall be at least 4 feet to provide for a 3 foot high fence after 1 foot of fabric is buried in the existing soil. Sections of fabric shall be joined in such a manner that, when in operation, the sections work effectively as a continuous fence. Fence posts shall be installed at a slight angle toward the anticipated runoff source.
   2. Heavy duty silt fence shall include a welded wire mesh backing for the geotextile. This welded steel wiremeshshallbegalvanizedandcontain4inchsquare openings. The geotextile shall be secured to the welded wire mesh.

B. Haybale Check Dams with Temporary Stone Outlets
   1. Haybales shall be embedded 4 inches into the ground and anchored in place with 2 wood stakes per bale. The temporary stone outlets, consisting of riprap stones

conforming to the requirements for temporary riprap, shall be placed in the center of each flow line. Coarse aggregate, conforming to ASTM C-33 size No. 2, shall be placed immediately upgrade of each stone outlet.

2. The riprap stones and coarse aggregate shall be placed on geotextile, and shall be embedded into the ground. When sections of geotextile need to be joined, the sections shall be overlapped a minimum of 18 inches in the direction of flow.

C. Temporary Stone Check Dams
   1. Temporary stone check dams shall be constructed in ditches to reduce flow velocity.
   2. The check dams shall consist of riprap stones conforming to the requirements for temporary riprap. Coarse aggregate, conforming to ASTM C-33 size No. 2, shall be placed immediately upgrade of each check dam.
   3. The riprap stones and coarse aggregate shall be placed on geotextile and shall be embedded in the ground. When sections of geotextile need to be joined, the sections shall be overlapped a minimum of 18 inches in the direction of flow.

D. Temporary Slope Drains
   1. Temporary slope drains shall be installed on embankment slopes to intercept surface runoff where concentrated runoff will cause excessive erosion of the slope.
   2. The drain pipe shall be staked to the slope or secured with riprap stones to prevent movement or displacement. A flared end section shall be attached at each end of the pipe and elbows shall be installed as required to conform wit h the existing changes in slopes.
   3. A temporary earth berm and haybales shall be constructed at the top of slope in the vicinity of the slope drain to intercept runoff and channel the runoff to the slope drain. The haybales shall be embedded 4 inches into the ground and anchored in place with 2 wood stakes per bale.
   4. Riprap stones, conforming to the requirements for temporary riprap, shall be placed loosely at both ends of the pipe to prevent scour. The riprap stones shall be placed on geotextile which, at the top of slope, shall be draped over the earth berm. When sections of geotextile fabric need to be joined, the sections shall be overlapped a minimum of 18 inches in the direction of flow.

E. Inlet Filters
   1. For existing inlet structures, geotextile shall be placed under the grates, over the curb pieces and extend a minimum of 6 inches beyond. Coarse aggregate, size No. 8, shall be placed behind each curb piece and on the geotextile to secure the in place.
   2. Openings required in new inlet walls to provide for temporary drainage shall be covered with welded wire mesh, geotextile and coarse aggregate, size No. 8.
   3. Inlet filters, consisting of welded steel wire mesh and geotextile shall be installed to control sedimentation at new inlet drainage structures. Inlet filters of geotextile alone shall be installed to control sedimentation at existing inlet drainage structures.

4. For new inlet structures, welded steel wire mesh shall be molded around the inlet frames and grates, or inlet structures, and extend a minimum of 6 inches down each side of the new structures. Geotextile shall then be secured to the welded wire mesh. Coarse aggregate, size No. 8, shall be placed against the inlet structures to hold the inlet filter in place.
5. Inlet filters shall be removed before scheduled paving operations begin.

F. Inlet Protection (Haybale Barrier)
1. Inlet protection (haybale barrier) shall consist of haybales which completely encircle inlet drainage structures. The perimeter length of the haybale barrier shall be at least four times the perimeter length of the inlet structure. Haybales shall not encroach into the traveled way.
2. Haybales placed around inlet structures within earthen areas shall be embedded 4 inches into the ground and anchored in place with 2 wood stakes per bale. Haybales placed around inlet structures within pavement areas shall be placed on top of the pavement, tied together to prevent movement and shall not be anchored in place.

G. Inlet Sediment Traps
1. Inlet sediment traps, consisting of silt fence and temporary stone inlets, shall be constructed to control sedimentation at existing and proposed inlet drainage structures.
2. The silt fence shall consist of geotextile whose width shall be at least 3 feet to provide for a 2 foot high fence after 1 foot of geotextile is buried in the existing soil. Sections of geotextile shall be joined in such a manner that, when in operation, the sections work effectively as a continuous fence. The silt fence shall be installed around the drainage structure and into the stone inlets. Fence posts shall be installed at a slight angle toward the anticipated flow.
3. The temporary stone inlets, consisting of coarse aggregate, conforming to ASTM C-33 size No. 2, shall be placed in each flow line upgrade of the inlet structure. The coarse aggregate shall be placed on geotextile which shall be buried in the soil. When sections of geotextile need to be joined, the sections shall be overlapped a minimum of 18 inches in the direction of flow.

H. Temporary Stone Outlet Sediment Traps
1. Temporary stone outlet sediment traps, consisting of temporary basins and riprap spillways, shall be constructed within existing, proposed and temporary ditches.
2. The spillways shall consist of riprap stones conforming to the requirements for temporary riprap. Coarse aggregate, conforming to ASTM C-33 size No. 2, shall be placed immediately upgrade of the spillways.
3. The riprap stones and coarse aggregate shall be placed on geotextile which shall be buried in the soil. When sections of geotextile need to be joined, the sections shall be overlapped a minimum of 18 inches in the direction of flow.

I. Dewatering Basin

1. Dewatering basins shall be constructed within the Site and outside any undisturbed wetland area, and areas not affected by roadway construction, as a dewatering containment measure in order to control sediment and provide filtration of water.
2. The dewatering basins shall be sized by the Contractor to entirely contain the expected discharge of water and sediment based on the flow rate of the pump to be used and the volume of water present within the area to be dewatered. The material to be used to form the basin is at the discretion of the Contractor. The outfall of the basin shall be such that the water exiting the basin does not cause erosion to, or scouring of, the area onto which the water is being discharged.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clearing and grubbing operations shall be so scheduled and performed that grading, mulching, seeding and other permanent pollution control features can follow immediately thereafter according to the approved progress schedule. Should seasonal limitations make such coordination unattainable, additional temporary soil erosion and sediment control measures shall be performed between successive construction stages, as directed.

B. The amount of surface area of erodible earth material exposed at one time by clearing and grubbing, excavation, borrow or fill operations, without stabilization, shall not exceed 750,000 square feet for clearing and grubbing operations, or 750,000 square feet for grading operations without prior approval. The Engineer may increase o r decrease these amounts commensurate with the Contractor's ability to keep the construction on the approved progress schedule.

C. Obtain the Engineer's approval before starting any operations which would require seeding for stabilization when seeding is restricted by the calendar limitations of the Section entitled "SEEDING". Approval will be based on the Contractor's alternate method for stabilizing disturbed areas when seeding is not reasonable due to seasonal constraints. The alternate method shall be approved by the Engineer before implementation and may include use of the Dust Retardant or other methods.

3.02 INSTALLATION

A. Embankment Areas
   1. Side ditches shall be excavated and stabilized, and perimeter soil erosion and sediment controls installed, before beginning all earthwork. Stabilization for the ditches and swales shall consist of seed, mulch, topsoil stabilization matting or temporary riprap, as required to prevent erosion.
   2. Embankment greater than 25 feet in height shall be stabilized in stages of equal increments not to exceed 15 feet. Each stage shall be either temporarily seeded and mulched, or permanently stabilized, before proceeding with the next stage. At the completion of the final stage of embankment placement, the entire slope, if not previously done, shall be permanently stabilized.

3. At the end of each work day, temporary stabilized earth berms and slope drains shall be constructed along the top edges of the embankment to intercept surface runoff.

B. Excavation Areas
   1. Ditches to be used in a cut section, and side and outlet ditches, shall be excavated and stabilized, and perimeter soil erosion and sediment controls installed, before beginning all earthwork. Stabilization for the ditches shall consist of seed, mulch, topsoil stabilization matting or temporary riprap, as required to prevent erosion.
   2. Slopes greater than 25 feet in height shall be excavated and stabilized in stages of equal increments not to exceed 15 feet. Each stage shall be permanently stabilized before proceeding with the next stage, in accordance with the time limitations specified herein.

C. Dust Control
   1. Employ construction methods and means that keep flying dust to a minimum. Provide for the laying of water or other dust control materials on the project and on roads, streets and other areas immediately adjacent to the project limits, and wherever traffic or buildings that are occupied or in use are affected by such dust caused by his hauling or other construction operations. The materials and methods used for dust control shall be as specified herein or as directed by the Engineer.
   2. Apply Dust Retardant in accordance with the manufacturer's written instructions. Reapply as often as required. Calcium chloride shall not be used in any areas to be seeded or landscaped.
   3. Calcium chloride may only be used on pavement subgrades subject to the approval of the Engineer. Care shall be exercised when using calcium chloride on steep slopes to prevent the calcium chloride from washing into streams or accumulating around plants or in landscape areas. Calcium chloride shall not be applied in solution. Apply calcium chloride at a rate of approximately 1.5 pounds per square yard.

D. Dirt Control
   1. The Contractor shall provide for prompt removal from existing roadways of all dirt and other materials that have been spilled, washed, tracked or otherwise deposited thereon by his hauling and other operations, whenever the accumulation is sufficient to cause the formation of mud, interfere with drainage, damage pavements or create a traffic hazard.
   2. In order to minimize tracking of dirt and other materials onto existing roadways, a stabilized construction driveway shall be constructed at locations where vehicles exit a work site. The construction driveway shall consist of a layer of broken stone, which shall be a minimum 4 inches thick and 100 feet long where practical, and of sufficient width to serve the intended purpose. The broken stone shall be 2 1/2 – inch nominal size conforming to ASTM C-33 size No. 2. The driveway shall be maintained by top dressing with additional stone, as directed, and shall be removed when no longer required.

E. Seeding

1. Temporary and permanent seeding shall be in accordance with the Section entitled "SEEDING".

3.03 SOIL EROSION AND SEDIMENT CONTROL MAINTENANCE

A. Soil erosion and sediment control measures shall be maintained during the Contract even when the Work is suspended. Controls shall be inspected immediately after each rain, and any required corrective work shall immediately be performed. Riprap stones, coarse aggregate, silt fence, or haybales damaged due to washouts or siltation shall be replaced.

B. Sediment traps and basins shall be cleaned out when they are 50 percent filled. Silt fences, stone outlet structures, dams, and haybales shall have sediment removed when the sediment reaches 50 percent of the height of the soil erosion and sediment control measure. Sediment removed shall be disposed of in accordance with the Contract Drawings.

++ END OF SECTION ++

SECTION 02301

FLOWABLE FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Filling with Flowable Fill for building volume below grade or below elevated slabs.

B. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

1.02 PRICE AND PAYMENT PROCEDURES

A. Structural Fill:
   1. Measurement Method: By the square yard (square meter).
   2. Includes: Supplying fill, preparing access points and openings and placing flowable fill where required.

1.03 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

B. Subgrade Elevations: Indicated on drawings.

C. Flowable fill - Ready-mix Controlled Low Strength Material (CLSM) used as an alternative to compacted soil, and is also known as controlled density fill, and several other names, some of which are trademark names of material suppliers. Flowable fill (Controlled Low Strength Material) differs from portland cement concrete as it contains a low cementitious content to reduce strength development for possible future removal. Unless specifically approved otherwise, by the Engineer, flowable fill shall be designed as a permanent material, not designed for future removal. Design strength for this permanent type flowable fill shall be a compressive strength of 1.38 MPa (200 psi) minimum at 28 days. Chemical admixtures may also be used in flowable fill to modify performance properties of strength, flow, set and permeability.

1.04 REFERENCE STANDARDS

A. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18 in.) Drop; 2021, with Errata (2022).

B. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

C. ASTM C618 - Standard Specifications for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as Mineral Admixture in Concrete.

D. ASTM C403/C403M - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.

E. ASTM C150 Rev.A-04 - Standard Specification for Portland Cement

F. ASTM C33 - Standard Specification for Concrete Aggregates

G. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete

H. ASTM C940 - Standard Specification for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced - Aggregate Concrete in the Laboratory

1.05 SUBMITTALS

A. See section 01300 - Submittals.

B. Flowable fill Mix Design: Provide flowable fill mix design containing cement and water. At the contractor's option, it may also contain fly ash, aggregate, or chemical admixtures in any proportions such that the final product meets the strength and flow consistency, and shrinkage requirements included in this specifications.
   1. Test and Performance - Submit the following data:
      a. Flowable fill shall have a minimum strength of 1.38 MPa (200 psi) according to ASTM C 39 at 28 days after placement.
      b. Flowable fill shall have minimal subsidence and bleed water shrinkage. Evaporation of bleed water shall not result in shrinkage of more than 10.4 mm per m (1/8 inch per ft.) of flowable fill depth (for mixes containing high fly ash content). Measurement of a Final Bleeding shall be as measured in Section 10 of ASTM C 940 "Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
      c. Flowable fill shall have a unit weight of 1500 - 1900 kg/ cu. m (90 - 115 pcf)/measured at the point of placement after a 60 minute maximum ready-mix truck ride.
   2. Provide documentation that the admixture supplier has experience of at least one year, with the products being provided and any equipment required to obtain desired performance of the product.
   3. Manufacturer's Certificates: Provide the Engineer with a certification that the materials incorporated in the flowable fill, following achievement of the required strength, do not represent a threat to groundwater quality.

1.06 QUALITY ASSURANCE

A. Designer Qualifications: Perform design under direct supervision of a Professional

Engineer experienced in design of this type of work and licensed in New York.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.

C. Materials: For each type of material required for the work of this Section, provide primary materials that are the products of one manufacturer. Materials shall comply with recommendations of ACI 229, "Controlled Low Strength Materials."

D. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. Deliver and handle all products and equipment required, in strict compliance with manufacturer's recommendations. Protect from damage due to weather, excessive temperatures, and construction operations.

PART 2 PRODUCTS

2.01 FLOWABLE FILL MATERIALS

A. Flowable Fill: provide flowable fill containing, at a minimum, cementitious materials and water. Cementitious materials shall be portland cement, pozzolanic materials, or other self-cementing materials, or combinations thereof. The flowable fill mix design may also contain, fine aggregate or filler, and/or chemical admixtures in any proportions such that the final product meets the strength, flow consistency and shrinkage requirements included in this specification, as approved by the Engineer.

B. Portland Cement: ASTM C150, Type 1 or Type 2.

C. Mixing Water: Fresh, clean, and potable.

D. Slump; 6 inch minimum.

E. Air-Entraining Admixture: ASTM C260.

F. Chemical Admixtures: ASTM C494.

G. Aggregate: ASTM C33.

H. Fly Ash; ASTM C618, Class F or C

2.02 FLOWABLE FILL MIXTURE

A. Mix design shall produce a consistency that will result in a flowable product at the time of placement which does not require manual means to move it into place.

B. Flowable fill shall have a minimum strength of 1.38 MPa (200 psi) according to ASTM C39 at 28 days after placement.

C. Flowable fill shall have minimal subsidence and bleed water shrinkage. Evaporation of bleed water shall not result in shrinkage of more than 10.4 mm per m (1/8 inch per foot) of flowable fill depth (for mixes containing high fly ash content). Measurement of a Final Bleeding shall be as measured in Section 10 of ASTM C 940 "Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.

D. Flowable fill shall have a unit weight of 90 - 115 pcf measured at the point of placement after a 60 minute maximum ready-mix truck ride.

E. Flowable fill shall have an in-place yield of at least 98% of design yield for permanent type and a maximum of 110% of design yield for removable types at 1 year.

F. Provide equipment as recommended by the Manufacturer and comply with manufacturer's recommendations for the addition of additives, whether at the production plant or prior to placement at the site.

2.03 SOURCE QUALITY CONTROL

A. See Section 01660 - Quality Control, for general requirements for testing and analysis of soil material.

B. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.01 EXAMINATION

A. Identify required lines, levels, contours, and datum locations.

B. Examine conditions of substrates and other conditions under which work is to be performed and notify Resident Engineer, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.02 APPLICATION OF FLOWABLE FILL

A. Secure tanks, pipes and other members to be encased in flowable fill. Insure that there are no exposed metallic pipes, conduits, or other items that will be in contact with the

flowable fill after placement. If so, replace with non-metallic materials or apply manufacturers recommended coating to protect metallic objects before placing the flowable fill. Replacement or protection of metallic objects is subject to the approval of the Engineer.

3.03 FIELD QUALITY CONTROL

A. See Section 01416 – Special Inspections, for general requirements for field inspection and testing.

3.04 PROTECTION AND CURING

A. Protect exposed surfaces of flowable fill from premature drying, wash by rain or running water, wind, mechanical injury, and excessively hot or cold temperature. Curing method shall be subject to approval by the Engineer.

+ + END OF SECTION + +

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SECTION 02365

HELICAL PILES

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope Of Work

1. Provide all required labor, materials, equipment and supervision for installation of helical piles as shown on the Contract Drawings or as directed by the Engineer.
2. Before starting work, the Contractor shall check and verify governing dimensions and elevations and approximate locations of the existing structures affected by the work.
3. The tip elevation and capacity of each Helical Pile shall be certified by a licensed Professional Engineer.

B. Coordination:

1. Review installation procedures under other Sections and Contracts and coordinate them with the Work specified herein.
2. Notify other contractors in advance of the installation of the Work included herein to provide them with sufficient time for the installation and coordination of interrelated items that are included in their contracts and that must be installed in conjunction with the Work included in this Section.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements of related work are included in Division 01, Division 02, and Division 03 of these Specifications.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. New York State Building Construction Code.

1.4 SUBSURFACE CONDITIONS

A. Information on subsurface conditions is referenced under Division 1, General Requirements.

1.5 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, the Contractor shall submit the following:

1. Full data on type of pile proposed and on other equipment to be utilized, including but not limited to the following:

   a) Installation equipment.
   b) Torque Monitoring Devices.
   c) Helical Pile materials including lead section, extensions and adaptors.

2. A description and sketch or catalog data of the pile installation rig including: torque motor.

3. The proposed pile installation sequence referenced to the Contract Drawings pile plan.

4. Proposed pile installation procedures.

5. Qualifications of personnel supervising the performance of pile installation.

6. A pile identification plan, with pile numbers.

B. Installation Records:

1. The Construction Manager's 3rd Party Inspection Agency shall submit two copies of the installation record of each pile to the County not later than two days after installation is completed. Include the project name and number, name of contractors, pile location and pile capacity, date of installation, starting and finishing times, total installation time, rate of operation of pile installation equipment, pile dimensions, tip elevation, elevation of butt, ground elevation, pile deviation, and any unusual occurrences during pile installation.

2. Submit Record Drawings showing exact location of each pile as installed.

1.6 JOB CONDITIONS

A. Product Delivery, Storage and Handling:

1. Contractor shall deliver, store, handle and protect all products, materials and equipment in accordance with Section 01600, Materials and Equipment, and Section 01610, Transportation and Handling of Materials and Equipment.

2. Deliver materials to the site in such quantities and at such times to assure the continuity of pile installation operations to the project schedule.

B. Site Information:

1. Test borings and other exploratory operations may be made by the Contractor at no additional cost to the County, provided such operations are acceptable to the Engineer, in accordance with contract documents.

C. Line and Level:

1. A benchmark and a base line will be established on the site for the use of the Contractor in establishing lines and levels for the work. The Contractor shall establish and locate all other lines and levels and be responsible for the correct location and deviation measurements of all piles.

D. Protection:

1. Protect structures, underground utilities and other construction from damage caused by pile installation operations.

2. When structures are adjacent to pile installation operations, provide surveyed elevation benchmarks on structures where directed by the Engineer before commencing Work. Record and report the elevation of each benchmark while pile installation is in progress. Should benchmark readings indicate any displacement, halt operations and provide corrective action acceptable to the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Helical Piles

Each helical pile shall consist of a 2-7/8 inch diameter x 0.203 inch thick galvanized steel pipe pile helical lead, extension sections and new construction bracket as manufactured by MacLean-Dixie or an approved equal.

The lead section shall consist of 2-7/8 inch diameter x 0.203 inch thick pipe with a minimum of 1 helical formed plate welded to it. The pipe shall be steel with a hot dipped galvanized coating. The smallest helix size shall be a minimum of 8 inches. The lead section unit shall be the load carrying element that transfers the load to the soil.

The termination end of the extension shall consist of 2-7/8 inch diameter x 0.203" thick steel pipe, with hot dipped galvanized coating. Each extension shall be provided with a means for coupling to the lead or to another extension. Each coupling shall be provided with the proper bolts and nuts. Extension lengths shall be chosen by the Contractor as required for installation.

All bolts shall be in accordance with ASTM A325 Type 1. All welding shall be done by certified welders in accordance with ASW D1.1.

All material shall be hot dipped galvanized in accordance with ASTM A153 or ASTM A123, where applicable. All galvanizing of welded areas shall be cleaned and coated with approved galvanizing compound.

PART 3 EXECUTION

3.1 PRE-INSTALLATION WORK

A. Installer must examine the areas and conditions wherever piles are to be installed.

B. Site Conditions: Do not install piles until earthwork in area which piles are to occupy has been completed, as follows:

1. Excavations: Earth excavation shall be complete to the bottom of cap before piles are installed.
2. Fills: Fills shall be constructed and compacted to the bottom of pile cap prior to pile installation.

C. Demolish existing building, slabs, where required.

3.2 INSTALLATION

A. General

The installation and of all helical piles shall be done under the observation of the Construction Manager's 3rd Party Special Inspection Agency.

Helical Piles shall be carefully located as shown on the Contract Drawings and installed to a minimum tip elevation of (-)20.0. Helical piles shall be installed to an ultimate capacity of (8) tons.

The Contractor shall accurately locate the installation point of each helical pile.

Throughout the installation, constant down pressure shall be maintained and torque shall be applied in a smooth, continuous manner. The rate of helical pile installation rotation shall be in the range of 3 to 20 revolutions per minute.

If the minimum torque requirement has not been satisfied at the minimum depth, the Contractor shall continue installation using additional extension material until specified minimum torque levels are obtained.

As soon as possible, after completion of installation of piles, Contractor shall prepare an accurate survey made by a licensed surveyor and furnish the Engineer with a record showing the final position of the top of each pile and locations of unacceptable piles.

B. Equipment

A torque indicator shall be used for all installations. The minimum installed capacity shall be as indicated on the Contract Drawings.

Installation equipment shall have a maximum torque capability. Installation units shall consist of rotary type, torque motor with forward and reverse capability. Installation equipment shall be in good working order and shall be safe to operate.

Installation equipment shall be grounded as required.

Adapters shall be employed to safely connect the installation units to the helical piles.

The torque being applied by the installing units shall be monitored throughout the installation process.

C. Obstructions

If underground obstructions are encountered during installation, the Contractor shall remove and relocate the helical pile. The Contractor shall submit for approval the new location of the helical pile and any revisions to the pile caps or grade beams.

If the helical pile is damaged and cannot be reused as determined by the Engineer, an additional helical pile shall be installed at a new location. The Contractor shall incur all costs associated with additional helical piles required to replace those damaged during installation.

Piles which are damaged due to mishandling during delivery or installation shall be replaced with new piles at the Contractor's expense.

The Contractor shall accurately locate all existing and new buried pipes or structures within the project area prior to helical pile installation. Care shall be taken to prevent damage to buried piping and structures due to pile installation. Any damage caused to buried piping and structures resulting from pile installation shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

3.3 MEASUREMENT AND PAYMENT

1. The unit of measurement for Helical Piles shall be included in the lump sum price for the project as listed in Bid Item #1.

+ + END OF SECTION + +

SECTION 02430

MANHOLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: The Contractor shall furnish all labor, materials, equipment and incidentals necessary to provide all manholes shown, specified and otherwise required to complete the Work.

B. General:
   1. Structures shall conform in shape, size, dimensions, material, and other respects to the details shown or as ordered by the Engineer.
   2. Concrete shall conform to the requirements specified under Section 03300, Class A Cast-In-Place Concrete.
   3. Inverts shall conform accurately to the size and elevation of the adjoining pipes. Side inverts shall be curved and main inverts, where direction changes, shall be laid out in smooth curves of the longest possible radius which is tangent to the centerlines of adjoining pipelines.
   4. Frames and covers shall conform in shape, size, dimensions, materials and other respects to the details on the Drawings and the Specifications.

C. Related Sections:
   1. Section 02200, Earthwork.
   2. Section 03200, Concrete Reinforcing.
   3. Section 03300, Cast-In-Place Concrete.
   4. Division 15, Sections on Piping.

1.2 QUALITY ASSURANCE

A. General:
   1. The Contractor must give the Engineer twenty-four (24) hours written notice on Monday through Friday (excluding Holidays) plus travel time prior to the commencement of any manufacturing process or testing sequence for manhole components made of precast concrete.
   2. At the place of manufacture of precast concrete components, the Engineer reserves the right at all times:
      a. To inspect the materials, the processes of manufacture, and the records of analysis and tests.
      b. To select test specimens.
      c. To inspect and test manhole components, accessories and joint material.
      d. To inspect and test cast-in-place concrete.
   3. Upon delivery to the site the Engineer reserves the right to inspect and test:
      a. Manhole components, accessories and joint material.
      b. Cast-in-place concrete.
   4. All manhole components made of precast concrete delivered to the site shall be clearly marked at the factory with the date of manufacture and the manufacturer's identification. Omission of this information may be cause for rejection of the manhole components.

B. Design Calculations: The Contractor shall submit in the Shop Drawings the following design calculations conforming to the applicable requirements of the American Concrete Institute Standard - ACI 318:
   1. Load Calculations: The calculations shall verify that all manhole components will have the required strength to withstand the following loadings:
      a. Equivalent fluid pressure of 90 pounds per cubic foot.
      b. The maximum live load produced by H-20 loading as stipulated in the American Association of State Highway Transportation Officials (AASHTO).

2. Uplift Calculations: The calculations shall verify that all manhole components shall be designed with a factor of safety of 1.25 against uplift with the maximum groundwater level at elevation 7.00.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM C32, Sewer and Manhole Brick (made from Clay or Shale).
   2. ASTM C139, Concrete Masonry Units for Construction of Catch Basins and Manholes.
   3. ASTM C140, Sampling and Testing Concrete Masonry Units.
   4. ASTM C150, Standard Specification for Portland Cement
   5. ASTM C207, Hydrated Lime for Masonry Purposes.
   6. ASTM C478, Precast Reinforced Concrete Manhole Sections.
   7. ASTMC923, Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.

D. Manufacturer's Testing:
   1. Tests on reinforced concrete manhole components shall be in accordance with the "Physical Requirements" section of ASTM C478.
   2. The Contractor shall ensure that the manufacturer furnishing manholes under these Specifications shall be fully equipped with testing facilities of the approved type and capacity. The Contractor shall furnish the required number of specimens of manhole components at no additional cost to the Owner.
   3. Absorption Test:
      a. For every 100 manhole bases and manhole riser sections manufactured, one specimen shall be selected for an absorption test. As a minimum, one specimen representing a manhole base and manhole riser section shall be tested. The absorption test shall be performed in accordance with the requirements of ASTM C478.
      b. In the event any specimen fails to meet any of the requirements of the absorption test, then two additional test specimens shall be selected for each specimen that failed, from the lot represented by the specimen that failed. The additional specimens shall be tested; and should any one of these fail to meet the requirements specified, the entire lot represented by these tests shall be rejected.
   4. Compression Test:
      a. For each of the four manhole components made of precast and cast-in-place concrete (manhole base, manhole riser section, transition slab and top slab) compression tests shall be made on standard rodded concrete cylinders. A minimum of four concrete cylinders shall be molded for each day's production of a particular manhole component. Each cylinder representing a particular manhole component shall be molded from the same concrete batch utilized for the manufacture of the component. The concrete cylinders shall be tested in accordance with the specifications of ASTM C478 except for the required strengths of the cylinders, which shall be as follows:
         The strength of precast concrete shall be considered satisfactory if both of the following requirements are met:
         1) The average at 28 days of three consecutive strength tests equals or exceeds 4500 psi.
         2) No individual strength test falls below required strength by more than five hundred psi.
      b. In the event a concrete cylinder's compressive strength is unsatisfactory the manufacture shall select one of the following two options:
         1) The entire day's production of the manhole component represented by the test cylinder shall be rejected.
         2) The manufacturer shall have the option to drill two cores from manhole components represented by the unsatisfactory test cylinder and perform compression tests on the cores. The manhole component sampled shall be selected by the Engineer. Should the compression tests on these core samples meet the strength requirements as specified in this Section, the Engineer shall determine the

acceptability of all manhole components represented by the test, considering the results of the tests on the concrete cylinders as well. Based on the Engineer's evaluation, if the compression test for the cores is determined to be unacceptable the entire day's production of the manhole component represented by the core sample shall be rejected. The Engineer's decision shall be considered final.

5. Top and Transition Slabs:
   a. In lieu of a proof of design test for the top and transition slabs the Contractor shall submit in the Shop Drawings top slab and transition slab design calculations and Drawings for approval by the Engineer.
   b. The design calculations shall be in accordance with requirements specified in this Section.

1.3 SUBMITTALS

A. Submit for approval samples of brick, block, gaskets and all accessories required for the manholes.

B. For all manholes submit Shop Drawings for approval. Shop Drawings shall include, but not be limited to, the following information:
   1. Size and spacing of steel reinforcement.
   2. Wall and slab thicknesses.
   3. Concrete cover over steel reinforcement.
   4. Joint design between component manhole sections, show all dimensions.
   5. Concrete mix design including design compressive strength.
   6. Design of flexible manhole seal assemblies.
   7. Final grade elevation at manhole.
   8. All pipe penetrations into manhole.
   9. Plan of manhole base invert.
   10. Design calculations and drawings.
   11. Certificates of compliance with referenced standards.
   12. Certified test results.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Manhole components shall not be shipped until the 28-day strength is reached.

B. Handle all manhole components carefully with approved handling devices. Manhole components shall be kept completely free from dirt and foreign matter.

C. Manhole components with damaged O-ring grooves will not be approved.

D. The Contractor shall clearly mark and immediately remove all damaged manhole components.

E. Certified copies of all test results shall accompany each manhole component shipment and shall be furnished to the Engineer with each shipment.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manholes shall conform to the details shown on the Contract Drawings. All concrete manhole bases, transition slabs, riser sections and top slabs shall be precast.

B. Except where otherwise specified manhole components shall conform to ASTM C478.

C. Precast manhole bases shall be of approved design and of sufficient strength to withstand the loads to be imposed upon them. An approved joint shall be provided to receive the pipe sections forming the barrel.

D. Mark date of manufacture and name or trademark of manufacturer on all precast concrete items.

E. Unless a larger size is required by the Drawings, the barrel of precast manholes shall be constructed of 48-inch diameter standard reinforced concrete manhole sections. the barrel shall be constructed of various lengths of pipe in combination to provide the correct height with the fewest joints. Wall sections shall not be less than 5 inches thick.

F. Unless shown otherwise on the Drawings, joints for all precast concrete manhole components shall be of the bell and spigot type with a round "O" ring rubber gasket or a preformed plastic sealing compound as specified in the Federal Specifications SS-S-210A. Joints shall be formed so that adjacent manhole sections will fit and seal properly.

G. A precast or cast-in-place slab or precast eccentric cone, as shown or approved, shall be provided at the top of the manhole barrel to receive the access hatches or cast iron frame and cover. The slab or cone shall be of acceptable design and of sufficient strength to safely support an H-20 loading. Concrete slabs shall be not less than 6 inches thick.

H. Manhole sections shall contain manhole steps, 12 inches on centers, accurately positioned and embedded in the concrete. Steps are specified under Section 05504, Miscellaneous Metal Fabrications.

I. All lifting holes shall be sealed tight with a solid rubber plug driven into the holes and the remaining void filled with 1 to 2 cement-sand mortar.

2.2 CASTINGS

A. General: All manhole frames and covers (standard and oversize) shall conform to the following requirements. All manhole frames shall be the adjustable types.

B. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM A48/A48M, Specification for Gray Iron Castings.
      b. ASTM B26/B26M, Specification for Aluminum-Alloy Sand Castings.

C. Gray Iron Castings: ASTM A48/A48M, Class 35B.

D. Round Manhole Frame with Solid Lid: Provide one of the following:
   1. R-1530, as manufactured by Neenah Foundry Company.
   2. E-1920, as manufactured by East Jordan Iron Works, Inc.
   3. Or equal.

E. Valve Box Frame and Lid: Provide one of the following:
   1. R-7506-F, as manufactured by Neenah Foundry Company.
   2. V-8450, as manufactured by East Jordan Iron Works, Inc.
   3. Or equal.

F. Coatings: Iron - Coat with asphaltic paint standard with the manufacturer.

2.3 BRICK MASONRY

A. General:
   1. Brick masonry shall be installed between the manhole top slab and the manhole casting, in order to set the manhole casting at the proper grade. Brick masonry shall also be utilized to close up both openings in manhole walls where future pipe connections are proposed and openings where existing pipes have been removed. The elevation and location of such bricked up openings shall be as shown on the Drawings or as directed by the Engineer.

B. Brick: All brick used as specified under this Section shall meet the requirements stated in ASTM C32.

C. Mortar and Plaster: All mortar and plaster required to complete brick masonry as shown on the Drawings or as specified herein shall be in conformance with the requirements stated in Section 04100, Mortar, except cement shall conform to ASTM C150 Type II.

2.4 STEEL REINFORCEMENT

A. Steel reinforcement shall be placed in all concrete manhole components as shown on the Drawings and as specified herein. The reinforcing shown on the Drawings is the minimum amount required. Design calculations shall be submitted in accordance with requirements specified in this Section. All steel reinforcement shall meet the requirements specified in Section 03200, Concrete Reinforcing.

2.5 TOP SLABS AND TRANSITION SLABS

A. Each top slab placed on the top of the manhole riser sections shall be manufactured in accordance with the Drawings and as specified herein.

B. Concrete slab thicknesses shall not be less than the dimensions shown on the Drawings.

C. Each top slab and transition slab shall be of acceptable design and of sufficient strength to safely support an AASHTO H-20 loading.

2.6 MANHOLE BASES AND MANHOLE RISER SECTIONS

A. The minimum diameter for each manhole base shall be as shown.

B. Manhole base sections minimum slab and wall thicknesses shall be as shown on the Drawings

C. Manhole riser sections shall have the following minimum diameter and minimum wall thickness as shown on the drawings.

D. Manhole riser sections shall be constructed of various lengths to provide the correct height with the fewest joints. No pipe penetrations shall be located at a joint.

2.7 PIPE CONNECTIONS

A. Each manhole base shall be provided with circular openings at the required locations and elevations for the proper connection of all pipes. Prior to manufacturing manhole, Contractor shall verify all elevations (grade elevations and pipe elevations) to ensure proper coordination with existing conditions.

B. Mortar shall be used to seal opening around the pipes entering the manholes. The diameter of the pipe opening shall be as shown on the Drawings.

2.8 MANHOLE RUNGS

A. The rung shall be of corrosion-resistant fiberglass construction.

B. Material of construction shall be protruded structural fiberglass utilizing a synthetic surfacing veil for chemical and ultraviolet resistance and special high modulus pultrusion process for strength. Minimum glass content shall be sixty (60%) percent, comprising both longitudinal strands and continuous strand mat so aligned as to prevent splitting due to laminar shear. The FRP shapes shall possess Class I fire retardance, with an ASTM E 84 flame-spread rating of twenty-five (25) maximum.

C. Each rung installed shall be subjected to a loading test of 300 lbs. and a pulling test of 300 lbs. Should any test fail, then the Contractor shall make repairs as approved by the Engineer.

D. Rungs shall be spaced at a maximum of 16-inch spacing and no less than 12-inch spacing.

E. Hardware (brackets, nuts, bolts, fasteners, etc.) shall be made of type 316 stainless steel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Excavation:
   1. All excavation required for the construction of manholes shall be performed as specified in Section 02200, Earthwork.

B. Shoring:
   1. Shoring of all excavations shall be provided as specified in Section 02200, Earthwork.

3.2 INSTALLATION

A. No manhole components shall be installed prior to the acceptance of all test results by the Engineer.

B. Manhole Bases:
   1. During excavation the soil below each base shall not be disturbed. Overexcavated areas shall be backfilled with select fill and compacted as specified in Section 02200, Earthwork. Manhole bases shall be checked for proper bearing on the subgrade and proper elevation and orientation to receive the incoming and outgoing pipes at the designated invert elevations. Special care shall be taken in placing the concrete around the bottom of the pipes to obtain a waterproof structure.
   2. Manhole Base Inverts:
      a. The concrete invert fill shall be installed following the connection of all sewer pipes to the manhole. The invert fill shall be true to the pipe invert elevations, with smooth channels of uniform section and slope, either straight or with continuous curve being provided between inlets and outlets of all manholes.
      b. The concrete invert fill shall also be placed in accordance with dimensions and details shown on the Drawings.
      c. To eliminate free fall conditions in a manhole resulting from grade differentials between incoming and outgoing pipes, the Contractor shall form and construct suitable channels in the bottom of the manhole of such configuration as approved by the Engineer in order to provide a smooth and even transition of flow through the manhole.

C. Manhole Riser Sections:
   1. Set sections vertical with sections in true alignment.
   2. Install sections, joints and gaskets in accordance with manufacturer recommendations.

D. Joints:
   1. Joints between manhole components shall be made with the materials specified in Paragraph 2.1.F of this Section.
   2. Gaps between sections shall not exceed 3/8-inch.

E. Manhole Watertightness:
   1. All manholes shall be free of visible leakage. Each manhole shall be periodically inspected for leaks, and all leaks shall be repaired in a manner subject to the Engineer's approval.

F. Brick Masonry:
   1. The brick masonry shall be constructed as required to bring the manhole frame and cover to the proper grade in accordance with the Drawings.
   2. Brick shall be satisfactorily wet when being laid and each brick shall be laid in mortar so as to form full bed, end and side joints in one operation. The joints shall not be wider then 3/8-inch, except when the bricks are laid radially, in which case the narrowest part of the joint shall not exceed 1/4-inch.
   3. Following the placement of the brickwork, a one half-inch layer of cement mortar shall be applied to the exterior surface of the brick and troweled to a smooth finish.
   4. If concrete grading rings are installed in lieu of brick masonry the combined height of the brick masonry and grading rings shall not exceed 12 inches.

G. Castings:
   1. Each casting shall be installed to the proper grade. Feathering of pavement around the casting is not permitted.

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SECTION 02465

AUGERED CAST-IN-PLACE PILES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: The Contractor shall furnish all labor, materials, tools, incidentals, and equipment necessary for furnishing, installing, cutting off and testing concrete augered cast-in-place piles and other appurtenances as shown on the Contract Drawings and specified herein. Also included are the following:

1. Test piles as indicated on the Drawings and as ordered in writing by the Engineer.
2. Pile load tests as ordered in writing by the Engineer. Load tests shall be performed on test piles prior to installation of production piles.
3. The extent of concrete augered cast-in-place piling shall be as shown on the Drawings and as ordered in writing by the Engineer.

B. Coordination:

1. Review installation procedures under other Sections and Contracts and coordinate them with the Work specified herein.
2. Notify other contractors in advance of the installation of the Work included herein to provide them with sufficient time for the installation and coordination of interrelated items that are included in their contracts and that must be installed in conjunction with the Work included in this Section.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements of related work are included in Division 01, Division 02, and Division 03 of these Specifications.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. New York State Building Construction Code.

2. American Society for Testing and Materials (ASTM):

ASTM D1143 Standard for Test Methods for Deep Foundations Under Static Axial Compressive Load.

ASTM D3966 Standard Test Methods for Deep Foundations Under Lateral Load.

ASTM D3689 Standard Method for Testing Individual Piles under Static Axial Tensile Load.

ASTM C939 Test Method for Flow of Grout of Preplaced Aggregate Concrete.

ASTM C109 Standard Method for Compressive Strength of Hydraulic Cement Mortars (using 2-inch cube specimens)

ASTM D1586 Standard method for Penetration Test and Split Barrel Sampling of Soils.

B. Inspection:

1. Grout Cubes shall be obtained, during installation of piling Work, by an independent Testing Laboratory retained by the Construction Manager's 3rd Party Special Inspection Agency.

C. Load Test:

1. A minimum of two (2) compression load tests are required at each new structure, per the requirements of ASTM D1143-20 as modified herein and as directed by the Engineer.

2. A minimum of two (2) lateral load tests are required at each new structure, per the requirements of ASTM D3966-22 as modified herein and as directed by the Engineer.

D. Pile Design Load:

1. The required safe working capacity for piles shall be 40 tons downward, as determined by load tests.

2. The required lateral capacity for piles shall be 2.75 tons, as determined by load tests.

1.4 SUBSURFACE CONDITIONS

A. Information on subsurface conditions is referenced under Division 1, General Requirements.

1.5 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 – Additional Submittals, the Contractor shall submit the following:

1. Full data on type of pile proposed and on other equipment to be utilized.

2. A description and sketch or catalog data of the pile installation rig including: leads, auger, grout pump and auger motor.

3. The proposed pile installation sequence referenced to the Contract Drawings pile plan.

4. Proposed pile installation procedures.

5. Qualifications of personnel supervising the performance of pile installation.

6. A pile numbering plan, with production pile numbers matching the numbering indicated on contract drawings, and any additional piles used as test piles and reaction piles in the load test set ups. Test pile numbers shall be designated by a "TP-X" designation, where TP indicates Test Pile and X indicates the pile number. Reaction pile numbers shall be designated a "RP-X" designation, where RP indicates Reaction Pile and X indicates the pile number.

7. Complete data on pile load test equipment instrumentation, load equipment calibration, load application and protection, if any.

8. Calculations and drawings of all load test set-ups, including but not limited to all loading apparatus, loaded members, support frames, reaction members and procedures shall be designed and sealed by a professional engineer, licensed in the State of New York, and submitted for approval.

9. The proportioning of mortar and installation of augered cast-in-place piles shall be performed in accordance with the provisions of these Specifications. Provide a description of the materials to be used and the proposed method of operations, and furnish records and data to demonstrate that the finished piles will meet, in all respects, the quality and properties required by these Specifications.

B. Load Test Reports:

1. Submit 2 copies of each pile load test report for each load test within 2 days after completion of tests. Pile load test reports shall include, but not be limited to, test results, a summary of test pile movement at 100% Design Load, 200% Design Load, and net permanent set after rebound, as well as the allowable capacity of the test pile. Load test reports shall be sealed by a Professional Engineer, licensed in the state of New York.

C. Installation Records:

1. The Construction Manager's 3rd Party Special Inspection Agency shall be responsible for inspecting all index, test, reaction, and production piles, and shall submit two copies of the installation record of each pile to the Engineer not later than two days after installation is completed. Include the project name and number, name of contractors, pile location and pile capacity, date of installation, starting and finishing times, total installation time, rate of operation of pile installation equipment, pile dimensions, tip elevation, elevation of butt, ground elevation, quantity of mortar placed, reinforcing placed, pile deviation, and any unusual occurrences during pile installation.

2. Submit Record Drawings showing exact location of each pile as installed.

3. Upon completion, provide a summary of all piles installed. The pile summary shall be sealed by a Professional Engineer, licensed in the state of New York.

D. Record Drawings: During progress of the Work, keep an up to date set of Drawings showing field and Working Drawings modifications. Immediately upon completion of work, provide Record Drawings showing the actual in-place installation of all Work constructed and/or installed under this Section as specified in General Conditions Section GC-36. Drawings shall include all necessary plans, sections and details, with all reference dimensions and elevations required for complete Record Drawings of the Work.

E. Grout Mix Design and Test Reports: Ten days prior to start of the Work, the proposed grout mix design and flow cone and strength test results on samples of grout demonstrating conformance to contract requirements shall be submitted to the Engineer.

1.6 JOB CONDITIONS

A. Product Delivery, Storage and Handling:

1. Contractor shall deliver, store, handle and protect all products, materials and equipment in accordance with Section 01600, Materials and Equipment, and Section 01610, Transportation and Handling of Materials and Equipment.

2. Supplier of grout shall be located in close proximity to the project and not more than 30 minutes driving time away.

3. Except for piles to be used for test purposes, materials ordered or delivered to the site prior to verification of the assumed pile length, will be at the Contractor's risk.

4. After pile lengths are verified, deliver materials to the site in such quantities and at such times to assure the continuity of pile installation operations to the project schedule.

B. Site Information:

1. Test borings and other exploratory operations may be made by the Contractor at no additional cost to the County, provided such operations are acceptable to the Engineer, in accordance with contract documents.

C. Line and Level:

1. A benchmark and a base line will be established on the site for the use of the Contractor in establishing lines and levels for the work. The Contractor shall establish and locate all other lines and levels and be responsible for the correct location and deviation measurements of all piles.

D. Protection:

1. Protect structures, underground utilities and other construction from damage caused by pile installation operations.

2. When structures are adjacent to pile installation operations, provide surveyed elevation benchmarks on structures where directed by the Engineer before commencing Work. Record and report the elevation of each benchmark at least twice a day while pile installation is in progress. Should benchmark readings indicate any displacement, halt operations and provide corrective action acceptable to the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete shall conform to the requirements of Section 03300, Cast-In-Place Concrete, except coarse aggregate is not required and except as specified herein.

1. Portland cement shall conform to current ASTM C150.

2. Pozzolan shall, if used, conform to ASTM C618, Class F.

3. If the Contractor elects to use a grout fluidifier, he shall submit manufacturer's data on the use of this product to the Engineer for review and approval.

4. Water shall be fresh, clean, and free from injurious amounts of sewage, oil, acid, alkali, salts, or inorganic matter.

5. Other admixtures shall not be used.

6. Fine aggregate shall meet the requirements of current ASTM C33 standards, except that grading may be modified if compressive strength requirements are satisfied.

B. Reinforcing Bars shall be epoxy coated and shall have a minimum yield of 60,000 psi and shall conform to the requirements of Section 03200, Concrete Reinforcing.

C. Grout Mix for Augered Cast-In-Place Piles:

1. The grout used to fill the holes shall consist of a mixture of Portland cement, fluidifier, sand and water so proportioned and mixed as to provide a mortar capable of maintaining the solids in suspension without appreciable water gain yet which may be placed without difficulty, and which will laterally penetrate and fill any voids in the foundation material. The materials shall be so proportioned as to provide a hardened mortar having an ultimate compressive strength of 4,000 psi at 28 days when tested in accordance with provisions of ASTM C109.

2. The mortar mix shall be tested by the Testing Laboratory at the County's expense by making one set of 2 inch cubes in accordance with ASTM C109 and C492 for each day during which piles are placed. A set of cubes shall consist of 3 cubes to be tested at 7 days and 3 cubes to be tested at 28 days. All samples to be taken at the mid-point of installation of a pile.

3. Only approved pumping, continuous mixing and agitating equipment shall be used in the preparation and handling of the mortar. All oil or other rust

inhibitors shall be removed from mixing drums and mortar pumps. All materials shall be such as to produce homogeneous mortar of the desired consistency.

4. The mortar pump shall be a positive displacement piston type pump capable of developing displacing pressures at the pump up to 350 psi. The minimum volume of mortar pumped for each hole shall be at least equal to 125% of the volume of the augered hole.

2.2 EQUIPMENT FOR INSTALLING PILES

A. Equipment for Installing Augered Cast-In-Place Piles:

1. The hole through which the high-strength mortar is pumped during the placement of the pile shall be located at the bottom of the auger head, below the bar containing the cutting teeth.

2. The auger flighting shall be continuous from the auger head to the top of auger with no gaps or other breaks. The pitch of the auger flighting shall not exceed 9 inches.

3. Augers over 40 feet in length shall contain a middle guide.

4. The piling leads shall be prevented from rotating by a stabilizing arm.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION WORK

A. Installer must examine the areas and conditions wherever piles are to be installed.

B. Site Conditions: Do not install piles until earthwork in area which piles are to occupy has been completed, as follows:

1. Excavations: Earth excavation shall be complete to the bottom of cap before piles are installed.
2. Fills: Fills shall be constructed and compacted to the bottom of pile cap prior to pile installation.

3.2 GENERAL REQUIREMENTS

A. Piles shall be installed with due consideration for the safety of adjacent structures, existing active utilities, by a method which leaves their strength unimpaired and which develops and retains the required load bearing capacity.

B. Augered cast-in-place piles shall be made by rotating a 12-inch diameter continuous-flight hollow-shaft auger into the ground to a minimum tip Elevation indicated, for each structure, on the Contract Drawings or as directed by the Engineer. Mortar shall then be injected through the auger shaft as the auger is being withdrawn in such a way as to exert removing pressure on the earth filled auger as it is being withdrawn as well as lateral pressure on the soil surrounding the mortar filled pile hole. Reinforcing shall be placed through the center hole of the auger, prior to grout injection, or shall be fitted with centralizers and installed into the freshly grouted pile immediately following grout injection.

C. Each pile shall contain a 1.00-inch diameter (No.8) reinforcing bar for compression pile conforming to Section 03200 Reinforcing Steel, placed through the hollow shaft auger which shall act as the centralizer to assure minimum grout cover. The bar shall extend the full length of the pile in all piles.

D. A 26 gage minimum metal shell formed in a 12-inch diameter cylinder shall extend a minimum of 18 inches below pile cut off or 12-inch below subgrade at the time of installation, whichever is greater in length. The metal shell shall remain in place as a permanent part of the pile.

E. The Contractor shall submit a schedule for pile installation. Piles shall not be installed until the schedule is approved by the Engineer. Piles closest to existing structures shall be installed and tested first followed by piles progressively further away.

3.3 PILE INSTALLATION

A. General:

1. Piles shall only be installed in the presence of the engineer responsible for pile inspection.

2. The installation shall be performed in an orderly sequence progressing in one direction across each foundation element.

3. Continuously install each pile at the locations indicated, to the elevation determined for each pile by the Engineer.

4. Carefully maintain the center of gravity for each group or cluster of piles to conform to the locations shown.

5. When installing piles within 20 feet of existing structures, the weight of the augers and auger head shall be at least 7.0 kips to increase the rate of auger penetration. Auger rotation shall stop immediately upon reaching the maximum depth and shall not start again until grouting has begun.

6. In the event that non-augerable material is encountered, such as cobbles, boulders, rock ledge, metal, timbers or debris, which causes the rate of penetration to be reduced to less than one foot per minute or causes the pile to drift from its location, the pile shall be completed to the depth of the non-augerable material in accordance with these Specifications. The length of such short piles shall be included in the total linear feet of pile for payment. If required by the Engineer, one or more additional adjacent piles shall be placed and the length of these additional piles shall also be included in the total linear feet of piles for payment. Piles mistakenly placed by Contractor will not be paid for.

B. Installation:

1. Grout shall be placed in piles as soon as practical after mixing, and in no case shall grout be used which does not reach its final position in the pile within the times specified in Paragraph 3 below.

2. Only approved mixing and pumping equipment shall be used in the preparation and handling of mortar. A screen to remove oversize particles shall be placed at the pump inlet. All soil or other rust inhibitors shall be removed from the mixing drums, stirring mechanisms, and other portions of the equipment in contact with mechanisms, and other portions of the equipment in contact with the mortar before the mixers are used.

3. All materials shall be accurately measured by volume or weight as they are fed into the mixer. Time of mixing shall be not less than one minute. If agitated continuously, the mortar may be held in the mixer or agitator for a period not exceeding 2-1/2 hours at grout temperatures below 70 F, and for a period not exceeding 2 hours at grout temperatures below 100 F. When a set retarding admixture is used, the mortar may be held for a period not exceeding 2 hours at grout temperatures below 85 F. When the ambient outdoor temperature exceeds 95 F, the mixing time shall not exceed 1-1/2 hours.

4. Accurate records shall be maintained showing the depth to which piles are placed and the quantity of mortar placed. Any unusual conditions encountered during pile installation shall be noted. The leads of the rig shall be clearly marked in one foot increments.

5. Piles installed the same day shall not be closer than six (6) pile diameters center to center of each other.

6. The hole in the bottom of the auger shall be plugged while the auger is being advanced into the ground. The plug shall be fabricated to fit snuggly into the

hole. The plug shall be removed by mortar pressure or with the reinforcing bar.

7. The mortar shall be pumped with initial pressure of approximately 250 psi at the pump as the auger is withdrawn allowing the mortar to fill the hole, preventing its collapse, and permitting lateral intrusion of the mortar into the surrounding soil. A second pressure gage shall be provided located as close to the auger rig as possible such that it is just touching the ground when the auger is in the raised position. The range of this gage shall not exceed twice the normal pumping pressure.

8. The mortar pump shall be provided with a calibrated pressure gauge in clear view of the equipment operator. A digital counter shall be used to measure the number of mortar pump strokes during installation. The mortar pump shall be calibrated at the beginning of Work to determine the number of pump strokes to fill a 55 gallon drum with mortar. The pump shall be re-calibrated following repair or switching pumps or at least once at the request of the Engineer during pile installation. The Contractor shall have on hand a spare counter and a spare pump. The spare pump shall be utilized when the primary pump is not functioning properly and when directed by the Engineer.

9. Positive rotation of the auger shall be maintained throughout placement of the grout. Rate of mortar injection and rate of auger withdrawal from the soil shall be so coordinated as to maintain at all times a positive pressure on these gauges, which will, in turn, indicate the existence of a removing pressure on the bottom of the auger flight in conformance with Section 3.2B of these Specifications. The total volume of mortar shall be at least 15 percent greater than the theoretical volume for each five foot segment of pile. The total volume of grout pumped shall be at least 25 percent greater than the theoretical volume of the pile. Do not withdraw auger until soil cuttings or water are observed issuing at the surface. If pumping of grout is interrupted for any reason or if a return at the surface is not noted, the Contractor shall reinsert the auger at least five feet into the pile and re-grout.

10. If less mortar is placed than the net volume required for any five-foot increment, the piles shall be reinstalled by rotating the auger to the bottom of the pile followed by controlled removal and mortar injection.

11. A head of at least ten feet of mortar above the injection point shall be maintained around the perimeter of the auger flights during raising of the auger so that the mortar has a displacing action, removing any loose material from the hole. This head shall be initially established by raising the auger six-inches from the bottom while rotating, pumping grout until a sufficient quantity is measured, lowering the auger to its original level and finally starting the removal process.

12. Auger hoisting equipment shall be so designed as to enable the auger to be withdrawn smoothly and steadily. Augers in excess of 40 feet in length shall be provided with a traveling guide.

13. Magnitude of removing pressure and performance of other augering and grouting operations such as the rate of augering, rate of grout injection, and control of grout return around the auger flight are dependent on soil conditions and equipment capability and shall be entirely the responsibility of the Contractor.

14. The spoil that accumulates around the auger during drilling and injection of the grout shall be continuously cleared away so that the installation can be properly inspected.

15. Provide protective cover for each pile after installation.

16. Test each truckload of grout using the Flow Cone Test ASTM C939, except a 3/4-inch opening is used rather than the 1/2-inch opening specified. Maintain grout fluidity of between 10 and 25 seconds.

17. Should water or ponding collect at the top of a freshly grouted pile, the water shall be removed immediately by bailing-out and replaced with fresh grout.

18. All piles, including test piles shall be reinforced as shown on the drawings.

C. Installation Tolerances:

1. Install piles within the following maximum tolerances:

a. Location: 3 inches from the location indicated for the center of gravity of each single pile or pile groups.

b. Plumbness: Maintain 2 inches in 10 feet from the vertical.

D. Corrective Action:

1. As soon as possible, after completion of installation of piles, Contractor shall prepare an accurate survey made by a licensed surveyor and furnish the Engineer with a record showing the final position of the top of each pile and locations of unacceptable piles.

2. The Engineer will check the piling and determine its acceptability. If not acceptable, he will advise the Contractor what additional piles must be furnished or other corrective measures to be taken.

3. Engineer will provide redesign required because of piles installed out of location. All corrective measures, including cost of Engineer's redesign, shall be at the Contractor's expense.

4. Partial surveys of piles at cutoff elevation may be submitted, as installation proceeds, in order to expedite the Work.

E. Jetting:

1. Jetting shall not be employed.

F. Damaged Piles or Piles Out of Tolerance:

1. Damaged piles, and piles installed outside the required installation tolerances, will not be accepted.

2. Cut-off and abandon piles rejected after installation, and replace with new piles.

3. Install additional piles where the centerline deviation exceeds 3 inches and a redesign indicates a load on any pile exceeding 110 percent of the design load. Where these additional piles necessitate changes in pile cap dimensions or reinforcement, Contractor shall carry out all corrective measures required to obtain the approval of the Engineer without additional cost to the County. Should it be impractical to install additional piles in particular situations, provide reinforced concrete straps or other measures as directed by the Engineer for redistributing the design loading, without additional cost to the County.

G. Cutting-Off:

1. Cut-off the tops of piles, square with pile axis and at the elevations determined from the Contract Drawings by removing fresh mortar from the top of the pile or by cutting off hardened mortar down to final cut-off point at any time after initial set has occurred.

H. Cold Weather Placing:

1. Protect mortar work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306.

I. Hot Weather Placing:

1. When hot weather conditions exist that would seriously impair the quality and strength of mortar, place mortar in compliance with ACI 305.

3.4 FIELD QUALITY CONTROL

A. Install and load test piles in order to confirm or modify design pile lengths. Pile load tests shall be performed in accordance with ASTM D1143-20, D3966-22 and as modified herein. Provide complete testing materials and equipment as required, and perform tests only in the presence of the Engineer. Test piles shall be installed and loaded from the excavation subgrade level.

B. Test piles and anchor piles, shall not be used as production piles, and shall not be incorporated into the proposed foundation of the new structure.

C. Test Piles Required:

1. Provide test piles for four (4) successful single pile load tests, at each new structure. Two (2) piles should be test loaded in compression and two (2) shall be test loaded laterally. The test piles shall be installed with reinforcing and tip levels indicated in the Contract Drawings. The Engineer may adjust the tip level based on the boring results.

D. Installing Test Piles:

1. Submittals required: The locations of the test piles shall be indicated on a Plan. In general, the locations of the test piles shall be located on opposite sides of the structure. The Contractor shall submit drawings and calculations showing the details of the pile test set up as required in ASTM D1143-20 and D3966-22 and the specific locations of the test piles. All drawings and calculations shall be sealed by a Professional Engineer, licensed in the state of New York.

2. Pre-pile installation: The Contractor shall retain a qualified boring Contractor to perform split spoon sample borings at each of the test locations and obtain samples at 2.5 feet intervals. The test piles shall be installed to a tip elevation indicated in the Contract Drawings, or as directed by the Engineer, for the test piles at each of the test locations. A hollow-stem auger will not be permitted to advance these holes.

3. At each pile test area, install test piles and anchor piles as shown on the approved pile test set up. Tip elevations shall be as indicated on the Drawings. All tests piles shall be installed from subgrade elevation of the proposed pile caps.

E. Pile Design Load:

1. The required safe working capacity for piles shall be 40 tons downward and 2.75 tons laterally.

F. Test Loads:

1. Load single test piles to twice the required design load.

G. Pile Load Testing - Downward Load:

General Load Test Requirements:

1. Pile load tests shall only be installed in the presence of the engineer responsible for pile inspection.

2. Perform a load test at each of the test locations in accordance with ASTM D1143-20 using Section 10.1.2, *Procedure A: Quick Test* and as modified herein. The maximum required load shall be two (2) times the design load or failure. Following unloading of the test under Section 10.1.2, rebound measurements shall be recorded for a minimum of 12 hours.

3. Augered cast-in-place piles, shall obtain the full design strength of the concrete, as determined by core samples or cylinder test results, prior to loading the pile.

4. The test load shall be applied by jacking with a hydraulic jack against a dead weight loaded platform or against a reaction beam attached to four or more anchor piles. The center to center spacing between test pile and closest anchor pile shall not be less than 9 feet for 12 inch diameter piles (8 feet minimum clear space between face of piles). Anchor piles shall not be included as part of the structures foundations therefore shall not be used as production piles. The hydraulic jack shall be equipped with an accumulator and the necessary gages and piping which shall transmit constant load to the pile with deviations of less than 500 pounds from the applied load. A calibration curve for the jack and gage to be used obtained within 7 days of the commencement of the load test and certified by a recognized testing laboratory shall be provided. Each load test shall include the use of a recently calibrated load cell and a ball joint to assure concentric loading of the pile top. A description of the operation of the accumulator and a working drawing of the proposed loading platform and dead weights or reaction beam and anchor piles to be used shall be submitted to the Engineer for approval, prior to the start of Work. Beam sizes and details of all connections shall be included.

5. Each load increment shall be held for a minimum of fifteen (15) minutes. Pile movement observations shall be made following application of each load increment and recorded at intervals of 1/2 minute, 1 minute, 2 minutes, 4 minutes, 8 minutes, and 15 minutes. The total test load (200% of design load) increment shall be maintained until the rate of movement is less than 0.010 inches per hour. Pile movement observations shall be made following application of the load increment and recorded at intervals of 1/2 minute, 1 minute, 2 minutes, 4 minutes, 8 minutes, and 15 minutes, 20 minutes, 30 minutes, 40 minutes, 60 minutes, and every 20 minutes thereafter. After all load has been removed from the pile, pile movement observation shall be recorded at intervals of 1/2 minute, 1 minute, 2 minutes, 4 minutes, 8 minutes, and 15 minutes, 20 minutes, 30 minutes, 40 minutes, 60 minutes, and 12 hours minimum.

6. Following completion of each load test, excavate around the test pile at each test site to a minimum of 6-ft. below grade to permit measurement of the pile cross section. The exposed portion of the pile shall be witnessed by the engineer responsible for the pile inspection.

H. Pile Load Testing - Lateral Load:

General Load Test Requirements:

1. Perform a load test each of the test locations in accordance with ASTM D3966-22 using Section 10.1.2, *Procedure A: Standard Loading*. The maximum required load shall be two (2) times the design load or failure.

2. Excavate or fill the test area to the final subgrade elevation within a radius of 20 ft from the test pile using the same material and backfilling methods as for production piles. Cut off or build up the test piles as necessary to permit construction of the load-application apparatus, placement of the necessary testing and instrumentation equipment, and observation of the instrumentation.

3. The test load shall be applied by jacking with a hydraulic jack against a dead weight loaded platform, or against a reaction beam attached to one or more reaction piles. Provide a clear distance between the test piles and the reaction piles or cribbing of at least 8 feet. Anchor piles shall not be included as part of the structures foundations therefore shall not be used as production piles. The hydraulic jack shall be equipped with an accumulator and the necessary gages and piping which shall transmit constant load to the pile with deviations of less than 500 pounds from the applied load. Each jack shall include a lubricated hemispherical bearing or similar device to minimize lateral loading of the pile or pile group. The hemispherical bearing(s) should include a locking mechanism for safe handling and setup.

A calibration curve for the jack and gage to be used obtained within 7 days of the commencement of the load test and certified by a recognized testing laboratory shall be provided. A description of the operation of the accumulator and a working drawing of the proposed loading platform and dead weights or reaction beam and anchor piles to be used shall be submitted to the Engineer for approval, prior to the start of Work. Beam sizes and details of all connections shall be included.

4. Maintain the groundwater level as near to the ground surface as possible and record the groundwater surface elevation during the test.

5. Augered cast-in-place piles, shall obtain the full design strength of the concrete, as determined by core samples or cylinder test results, prior to loading the pile.

6. Record readings before applying any test load, intermittently at each load increment, at the proposed design load, at the maximum test load, and after the removal of all load.

   Intermediate readings for each load increment shall be recorded at 1 minute, 2 minutes, 5 minutes, and each 5 minutes thereafter application of load increment except in the instance of total load where, after 15 minutes reading, the time interval shall be every 15 minutes until the final settlement limitation is reached and the load removed.

7. Following completion of each load test, excavate around the test pile at each test site to a minimum of 6-ft. below grade to permit measurement of the pile cross section. The exposed portion of the pile shall be witnessed by the engineer responsible for the pile inspection.

I. Preparation of Mortar Test Specimens:

1. Throughout each eight-hour shift, at least six test specimens of mortar shall be prepared by pouring mortar, taken from the auger discharge, into 2-inch by 2-inch cube molds and tested in accordance with CRD-C88.

   All test specimens shall be taken and tested by the Construction Manager's 3rd Party Special Inspection Agency.

J. Test Reports:

1. The Contractor shall retain a Professional Engineer, licensed in the state of New York, to observe the load tests, record all test data, prepare load test reports, and certify the Pile Capacity.

The Construction Manager's 3rd Party Special Inspection agency may observe the load tests, but will not be responsible for obtaining data and providing load test reports.

2. Pile load test reports shall include, but not be limited to, test results, a summary of test pile movement at 100% Design Load, 200% Design Load, and net permanent set after rebound, as well as the allowable capacity of the test pile.

3. Prepare reports for each test and reaction pile installed. The pile report shall include the following: date of installation, test pile location, ground elevation, ground designation and dimensions of pile, total penetration, starting and finishing times and total installation time, quantity of mortar placed, reinforcing placed, any unusual conditions encountered, and equipment used, including drill rig, pump information, and operating pressures.

4. All reports shall be prepared by, and sealed by a Professional Engineer, licensed in the state of New York.

3.5 MEASUREMENT AND PAYMENT

1. All costs for Production Piles shall be included in the lump sum price for the project as listed in Bid Item #1.

2. The Pile Load Tests to be paid for will be included in the lump sum price for the project as listed in Bid Item #1.

3. The payment for Pile Load Tests will be included in the lump sum price for the project as listed in Bid Item #1.
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The lump sum bid amount shall include two (2) successful compression load tests and two (2) successful lateral load tests. Any additional pile load test required to be performed for each unsuccessful load test, shall be at the Contractor's Expense.

4. As part of the lump sum price for the project as listed in Bid Item #1, the Contractor shall furnish all necessary design, supervision, labor, material, equipment, incidentals, and Engineering required to perform, inspect, and report, all work necessary to complete and certify the pile axial compression and lateral load tests. Anchor Piles and Test Piles which are not part of the permanent structure shall also be included in the lump sum price for the project as listed in Bid Item #1.

5. Final payment for the Pile Load Test is dependent on successful completion of the test, as determined by the Engineer.

+ + END OF SECTION + +

SECTION 02485

GRASSING AND PLANTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified, and required to do landscape work on all areas used by the Contractor for the Work, and on all areas disturbed by the Contractor's construction activities. This includes seeding/sodding around the new facility and manholes.
   2. Types of work required include, but are not limited to, the following:
      a. Provide topsoil from off-site sources if topsoil stockpiled under Section 02200, Earthwork, is insufficient to complete the Work of this Section.
      b. Provide new turf areas and recondition existing turf areas.
      c. Provide mulches and all other material necessary to complete the seeding job as specified.
      d. Maintenance work as specified.
      e. Provide soil amendments, fertilizers, wood pine chunk bark and miscellaneous materials.
      f. Provide sod (an alternate to seeding).
      g. Remove existing shrubs and trees from areas of new construction, store and re-plant on-site where directed by Engineer.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that shall be installed with the landscaping.
   2. Obstructions Below Ground and Utilities: Exercise extreme caution in all operations, as there are underground electric and telephone cables, sewer lines and water lines throughout the entire area. Study and be familiar with the location of these obstructions and underground utilities. Repair all damage to obstructions and underground utilities at no expense to the Owner.

C. Related Sections:
   1. Section 02200, Earthwork.

1.2 QUALITY ASSURANCE

A. Subcontractor Qualifications:
   1. Subcontract the Work to a single firm specializing in landscape work. Provide the services of an experienced foreman, who will personally supervise all Work.

B. Source Quality Control:
   1. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Analytical Chemists, wherever applicable or as further specified.
   2. Topsoil stockpiled for reuse: Topsoil will be inspected by the Engineer before reuse. At the time of inspection, the Engineer may require representative soil samples to be tested for physical properties, hydrogen-ion value, organic matter, and available phosphoric acid and potassium. Supply twenty-pound samples to the Owner for testing. If deficiencies in the topsoil are found, as a result of this analysis, they shall be corrected at no additional expense to the Owner.
   3. Provide sod procured from areas having growing conditions similar to those areas on which the sod is to be used.
   4. Machine-cut sod into rectangular sections, exercising care to retain the native soil on the roots of the sod, during stripping, transportation and planting.

5. Cut and move sod only when soil moisture conditions are such that favorable results can be expected.
6. Rectangular sections of sod may vary in length but shall be equal in width and of a size that permits the sod to be lifted and rolled without breaking.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
1. ASTM C602, Agricultural Liming Materials.
2. ASTM D2487, Classification of Soils for Engineering.
3. Association of Official Analytical Chemists, Official Methods of Analysis.
4. Official Seed Analysists of North America, Standards of Quality.
5. FSO-F-241D, Fertilizer, Mixed, Commercial.
6. FSO-P-166E, Peat Moss; Peat, Humus; and Peat, Reed-sedge.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
1. Wood pine chunk bark: One pound bag.

B. Shop Drawings: Submit for approval the following:
1. Planting schedule showing scheduled dates for each type of planting in each area of Site.
2. Before delivery of off-site topsoil, written statement giving the location of the properties from which the topsoil is to be obtained, the names and addresses of the suppliers, the depth to be stripped and the crops grown during the past 2 years.
3. Manufacturer's specifications and installation instructions for all materials required.

C. Tests by the Owner: Submit topsoil, seed, soil amendments and fertilizer to the Owner’s testing facility for testing:
1. Before delivery of off-site topsoil, a soil analysis will be made by the Owner’s testing laboratory for porosity, the percentages of silt, clay, sand and organic matter and the pH and the mineral and plant nutrient content of the topsoil. Supply topsoil with 5 percent organic matter minimum.
2. Before delivery of seed, soil amendments and fertilizer an analysis will be made by the Owner’s testing laboratory stating the mechanical and chemical analysis of the materials proposed for use.

D. Certificates: Submit for approval the following:
1. Certificates of inspection as may be required by governmental authorities to accompany shipments, and manufacturer's or vendors certified analysis for soil amendments and fertilizer materials. For standard products submit other data substantiating that materials comply with specified requirements.
2. Certificates from seed vendors certified statement for each seed mixture required, stating botanical and common name, percentage by weight and percentages of purity, germination, and weed seed for each species.
3. Before delivery of sod, submit written statement giving the locations of the property from which the sod is to be obtained and the names and addresses of the suppliers.
3. Certificates of inspection substantiating that sod contains no noxious weeds or other material that might be detrimental to the proposed planting.

1.4 JOB CONDITIONS

A. Environmental Requirements:

1. Proceed with and complete the Work as rapidly as portions of the Site become available, working within the seasonal limitations for each kind of landscape work required.
2. Do not spread seed when wind velocity exceeds 5 miles per hour.
3. Do not seed when drought, or excessive moisture, or other unsatisfactory conditions prevail.

B. Scheduling:
1. Seed or install materials only during normal planting seasons for each type of work required. Correlate seeding with specified maintenance periods to provide maintenance until completion of Work.
2. Sod: Time delivery so that sod will be placed within 24 hours after stripping.
3. Protect sod against drying and breaking of rolled strips.
4. If sod is stacked place roots to roots or grass to grass.
5. Protect sod from exposure to wind and sun and from freezing.

1.5 GUARANTEE

A. Guarantee turf through the specified maintenance period.

1.6 ALTERNATES

A. The Contractor, with the approval of the Engineer, may substitute sod as specified herein for the seeding specified. Submit a request to the Engineer in writing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil:
1. Topsoil shall be stockpiled for re-use in landscape work. If quantity of stockpiled topsoil is insufficient, provide additional topsoil as required to complete landscape work.
2. Provide off-site topsoil as required, which is fertile, friable, natural loam, surface soil, capable of sustaining vigorous plant growth, free of any admixture of subsoil, clods of hard earth, plants or roots, sticks or other extraneous material harmful to plant growth. Supply topsoil with the following analysis:
   a. 3/4-inch: 100 percent passing
      1/4-inch: 97-100 percent passing
      No. 100: 40 to 70 percent passing
      No. 200: 20 percent minimum
   b. ph 5.0 to pH 7. If approved by the Engineer, natural topsoil not having the hydrogen-ion value specified may be amended by the Contractor at his own expense.
   c. Organic content not less than 5 percent, not more than 20 percent.
   d. Free of pests and pest larvae.

B. Soil Amendments:
1. Lime: Natural limestone containing not less than 80 percent of total carbonates, ground so that not less than 100 percent passes a 10-mesh sieve, not less than 70 percent passes a 100-mesh sieve and not less than 50 percent passes a 200-mesh sieve.
2. Superphosphate: Soluble mixture of treated minerals; approximate 0-20-0 formulation, 18 percent available phosphoric acid.
3. Commercial Fertilizer: Complete fertilizer of neutral character, with a minimum of 50 percent nitrogen derived from natural organic sources or urea form; 50 percent of the nitrogen shall be inorganic. Available phosphoric acid derived from superphosphate, bone, or tankage. Potash derived from muriate of potash, containing 60 percent potash. Uniform in composition, free-flowing and suitable for application with approved equipment. Provide fertilizer with the following percentages of available plant nutrients:

a. For turf, provide fertilizer with not less than 6 percent phosphoric acid and not less than 4 percent potassium, and nitrogen not less than 10 percent. Provide nitrogen in a form that will be available to the turf during the initial period of growth.

4. Sand: Washed of fine to medium texture.

C. Turf Materials:

1. Lawn: Seed shall be state-certified seed of the latest season's crop and shall be delivered in original sealed packages bearing the producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Seed shall be labeled in conformance with U.S. Department of Agriculture rules and regulations under the Federal Seed Act. Seed that has become wet, moldy, or otherwise damaged will not be acceptable. On-site seed mixing shall be done only in the presence of the Owner. The seed mixture shall be proportioned as follows:

2. Mixtures:

a. Mixture A to be seeded, in general, on areas not regularly mowed.

MIXTURE A	Mixture Tolerance		Germination	
Proportions of Mixture	Minus	Plus	Germination	Minus
25% Lynn Rye	3%	5%	90%	6%
25% Baron Blue	3%	5%	85%	7%
25% Penn Fine Rye	3%	5%	90%	6%
25% Mustang Fescue	3%	5%	90%	6%

b. Mixture B to be seeded, in general, on areas regularly mowed and well-maintained.

MIXTURE B	Mixture Tolerance		Germination	
Proportions of Mixture	Minus	Plus	Germination	Minus
50% Merion Blue Grass	3%	5%	80%	7%
30% Penn Lawn Fescue	3%	5%	90%	6%
20% NK106 Hybrid Rye	3%	5%	85%	7%

D. Miscellaneous Landscape Materials:

1. Mulch:
   a. Anti-Erosion Mulch: Provide clean, seed-free wood fiber.
   b. Product and Manufacturer: Provide one of the following:
      1) Superior Fiber as manufactured by Wolbert Master and Associates, Inc.
      2) Silva Fiber as manufactured by Weyerhauser Corporation.
      3) Or equal.
2. Water: Potable.
3. Steel Edging: Commercial steel edging fabricated in sections with loops pressed from or welded to face of sections to receive stakes. Provide tapered steel stakes 16 inches long. Finish edging sections and stakes with manufacturer's standard black paint. Provide edging of the following cross-section size:
   a. 4 inches by 1/8 inch.
4. Gravel: Hard, durable, well graded stone washed free of loam, sand, clay and other foreign substances, and of the following size, range, and color:
   a. Size Range: 1-1/2 inch maximum, 3/4-inch minimum.
   b. Color: Uniform tan beige color range.
   c. Product and Manufacturer: Provide one of the following:

1) No. 245 Camel Brown as manufactured by George Scholfield Company, Incorporated.
2) Or equal.

5. Base Film: Provide 10 mil thick black polypropylene film in 10-foot widths.
6. Chunk Bark Mulch: Provide chunks of pine wood mulch with a nominal face dimension of 2 to 4 inches to a minimum finished depth of 5 inches.
7. Wrapping: Provide a standard manufactured tree wrapping paper, brown in color, two layers cemented together by asphaltum, crepe surface. Provide twine for tying, lightly tarred, medium coarse sisal (lath) yarn.

E. Sod: Provide strongly rooted machine-cut sod, not less than 2 years old and free of seeds and undesirable native grasses. Provide only sod capable of growth and development when planted (viable, not dormant) and in strips not more than 18-inches wide by 14 feet-0 inches long by 1-1/2 inches thick (excluding top growth and thatch). Provide sod composed of Mixture B above.

PART 3 - EXECUTION

3.1 INSPECTION

A. The Contractor and his installer shall examine the subgrade, verify the elevations, observe the conditions under which the grassing and gravel work is to be performed, and notify the Engineer of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

B. Inspect existing trees and shrubs to be relocated for injury and insect infestation. Prune as required before moving. Discard damaged trees and shrubs as directed by the Engineer.

C. Do not begin moving or storing of trees until deficiencies are corrected.

3.2 PREPARATION

A. Layout individual tree and shrub locations and areas for multiple plantings as directed by the Engineer. Stake locations and outline areas and secure the Engineer's acceptance before start of planting work. Make minor adjustments as may be requested. Refer to paragraph 1.1.B. herein for the requirements of coordination by others.

B. Move existing trees with full ball of earth. Take all measures necessary to avoid breaking earth ball. Dig earth ball same diameter as drip line of tree and to a depth 1/2 the diameter of earth ball minimum. Do not cut roots over 1/2-inch in diameter. Alter earth ball shape as required to avoid cutting roots. If trees cannot be planted immediately, cover earth ball with planting soil and maintain in moist condition. Keep plants out of full sun. Support plants with stakes to maintain upright and stable position. Plant as specified herein. Apply anti-desiccant as specified herein. Trees lost due to improper moving techniques shall be replaced in kind and size at no additional expense to the Owner.

C. Seedbed Preparation:
1. Loosen subgrade of seedbed areas to a minimum depth of 4 inches. Remove stones over 1-1/2 inches in any dimension and sticks, roots, rubbish and other extraneous matter. Limit preparation to areas that will be planted promptly after preparation.
2. Spread topsoil to minimum depth of 6 inches after natural settlement and light rolling.
   a. Do not spread topsoil while in a frozen or muddy condition.
3. Apply ground limestone, by machine, at a rate of 2,000 pounds per acre over all areas to receive turf, as required, to bring the soil to a neutral pH. Work lightly into the top 3 inches of topsoil at least five days before applying the commercial fertilizers.
4. Apply commercial fertilizers at a rate of 1500 pounds per acre within 10 days of seeding.

5. Thoroughly and evenly incorporate commercial fertilizers with the soil to depth of 3 inches by dicing, or other approved method.
    a. In areas inaccessible to power equipment, use hand tools.
6. Apply superphosphate at the rate of 20 pounds per 1000 square feet and incorporate into the top 3 inches of topsoil.
7. Grade seedbed areas to smooth, even surface with loose, uniformly fine texture. Remove all stones and extraneous foreign material in excess of 1 inch in diameter. Roll and rake and remove ridges and fill depressions, as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading.
8. Moisten prepared seedbed areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting. Do not create a muddy soil condition.
9. Restore turfbed areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

D. Preparation of Planting Beds:
1. Remove all existing soil from planting beds to the depth required so that finished plantings are level with adjacent final lines, grades and elevations after addition of planting soil to the depth shown on the Drawings and after light rolling and natural settlement.
2. Loosen subgrade of planting bed areas to a minimum depth of 6-inches using a culti-mulcher or similar equipment. Remove stones over 1-1/2-inches in any dimension, and sticks, stones, rubbish and other extraneous matter.
3. Place approximately 1/2 of total amount of planting soil required. Apply 10 pounds of superphosphate per 1000 square feet of bed. Work into top of loosened subgrade to create a transition layer, then place remainder of the planting soil.

E. Excavation for Trees and Shrubs:
1. Excavate pits with vertical sides and with bottom of excavation slightly raised at center to provide proper drainage. Loosen hard subsoil in bottom of excavation.
    a. For existing trees and shrubs to be replanted, make excavations at least twice as wide as the ball diameter and equal to the ball depth, plus the following allowance for setting of ball on a layer of compacted backfill:
        1) Allow for 6-inches setting layer of planting soil mixture.
2. Dispose of subsoil removed from landscape excavation. Do not mix with planting soil or use as backfill.

3.3 INSTALLATION

A. Determine location of underground utilities and perform Work in a manner which will avoid possible damage. Hand excavate, as required, to minimize possibility of damage to underground utilities. Maintain grade stakes until removal is mutually agreed upon by all parties concerned.

B. Planting Trees and Shrubs:
1. Set existing trees to be replanted on layer of compacted planting soil mixture, plumb, and hold rigidly in center of pit or trench with top of ball at same elevation as adjacent finished landscape grades. Maintain previous relationship that plant had to existing soil line at trunk or main leader. Do not set plants in depressions or on mounds. When set, place additional backfill around base and sides of ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3-full, water thoroughly before placing remainder of backfill. Water again after placing final layer of backfill. Remove burlap from sides of balls; retain on bottoms.
2. Dish top of backfill to allow for mulching. Provide dish 4 feet in diameter approximately 4-inches deep around each tree.
    a. For spring planting, provide additional backfill berm around edge of excavations to form shallow saucer to collect water.
3. Place water permeable base film over finished planting beds prior to placing planting bed mulch.

a. Lap joints 4-inches minimum.
b. Use one hold down pin per 4 square feet of film.
c. Take precaution not to tear or puncture base film further when placing planting bed mulch.

4. Mulch pits, trenches and planted areas. Provide not less than 5-inches of planting bed mulch and finish level with adjacent finish grades.

C. Seeding:
1. Seed only between April 15 and May 30 and between August 15 and October 1.
2. Sow seed at a rate of 150 pounds per acre using a spreader or seeding machine.
3. Distribute seed evenly over entire area by sowing equal quantity in 2 directions at right angles to each other.
4. Sow not less than the quantity of seed specified.
5. Cultivator-packer, or approved similar equipment, may be used to cover the seed and to firm the seedbed in one operation. In areas inaccessible to cultivator-packer:
a. Rake the seeded ground and roll in two directions with a water ballast roller, weighing not less than 100 pounds per linear foot.
b. Take care during raking that seed is not raked from one spot to another.
6. Protect seeded areas against erosion by spreading specified lawn mulch after completion of seeding operations.
a. Protect seeded areas against hot, dry weather or drying winds by applying straw mulch not more than 24 hours after completion of seeding operations.
7. Do not leave seeded areas unmulched for longer than 3 days. Reseed areas which remain without mulch for longer than 3 days.
8. Mulch shall be spread uniformly over the seeded area at the rate. Recommended by the manufacturer in writing.
9. Prevent foot or vehicular traffic, or the movement of equipment, over the mulched area. Reseed areas damaged as a result of such activity.
10. Water seeded areas thoroughly with a fine spray.

D. Hydro-Seeding:
1. Hydro seeding may be substituted for mechanical seeding with the approval of the Owner.
2. All requirements of "Seeding" hereinbefore specified shall apply except as modified herein.
3. Areas to be hydro-seeded shall be scarified sufficiently to break up the surface crust immediately before seeding as approved by the Owner except where the ground is loose and friable as immediately following grading or as otherwise approved.
4. Hydro-seeder slurry shall be a homogeneous mixture of seed, mulch, limestone and fertilizer that shall remain in suspension in water under agitation. The slurry shall be evenly distributed over the area to be seeded and shall be applied in accordance with the following application rates per acre of surface seeded.
5. 6,000 gallons of water, 2,000 pounds of wood fiber mulch, 200 pounds of grass seed mixture, 1,200 pounds of ground limestone, 90 pounds of 10-6-4 fertilizer.
6. Grass seed mixture used for Hydro-Seeding shall conform to "Mixture A" or “Mixture B” as specified in this Section.

E. Miscellaneous Landscape Work:
1. Install steel edging between all grassed and graveled areas. Anchor with steel stakes spaced not more than 3 feet on center and driven at least 1 foot below bottom elevation of edging.
2. Place water permeable base film over compacted subgrade prior to placing gravel.
a. Lap joints 4 inches minimum.
b. Use one hold-down pin per 4 square feet of film.
c. Take precautions not to tear or puncture base film when placing gravel.
3. Place gravel beds 6 inches deep. Compact soil subgrades before placing gravel.

F. Reconditioning Existing Turf:

1. Recondition areas outside of the clearing line damaged by the Contractor's operations including storage of materials and equipment and movement of vehicles. Also recondition existing turf areas where minor regrading is required.
2. Provide fertilizer, seed or sod and soil amendments as specified for new turf and as required to provide a satisfactory reconditioned turf. Provide new topsoil as required to fill low spots and meet new finish grades.
3. Cultivate bare and compacted areas thoroughly to provide a satisfactory planting bed.
4. Remove diseased and unsatisfactory turf areas; do not bury into soil. Remove topsoil containing foreign materials resulting from the Contractor's operations including oil drippings, stone, gravel and other loose building materials.
5. In areas approved by the Engineer, where substantial turf remains (but is thin), mow, rake, aerate if compacted, fill low spots, remove humps and cultivate soil, fertilize, and seed. Remove weeds before seeding or if extensive, apply selective chemical weed killers as required. Apply a seedbed mulch, if required, to maintain moist condition.
6. Water newly planted areas and keep moist until new turf is established.

G. Sodding Lawns:
1. Do not lay sod on ground that is frozen, dust dry or that has not been uniformly prepared as specified.
2. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to subgrade or sod.
3. Place sod strips in straight lines parallel to one another.
4. Immediately upon completion of a section of sodding, tamp, roll lightly and water, to ensure contact with subgrade and elimination of air pockets.
5. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass.
6. Peg sod on slopes as required to prevent slippage. Use 1-inch by 1-inch by 6-inch wooden pegs with one end sharpened.
7. Water sod throughly with a fine spray immediately after planting. Water sufficiently to insure penetration of moisture to bottom of prepared topsoil layer not just to bottom of sod blanket.

3.4 MAINTENANCE

A. Begin maintenance immediately after planting.

B. Maintain turf for 60 days minimum, and longer as required to establish an acceptable stand, as determined by the Engineer.

C. The Contractor shall supply required irrigation materials, equipment, and water.

D. Maintain lawns by watering, fertilizing, weeding, mowing, trimming and other operations such as rolling regrading and replanting as required to establish a smooth, acceptable lawn, free of eroded or bare areas.
1. Cutting Height: Mow lawns as soon as there is enough top growth to cut with mower set at the specified height for the principal species planted. Repeat mowing as required to maintain specified height. Do not remove more than 1/3 of grass height. Do not mow when grass is wet. Time initial and subsequent mowings as required to maintain the following grass height:
   a. Mow grass at 2-1/2-inch height. Do not mow lower than 1-1/2 inches.
2. Apply fertilizer after first mowing and when the grass is dry. Use fertilizer that will provide not less than 1.0 pound of actual nitrogen per 1000 square foot of lawn area.
3. Maintain grass for at least one mowing or for specified period whichever is first.

4. After grass has started, reseed repeatedly all areas greater than 8 inches square which fail to show a uniform stand of grass for any reason whatsoever until all areas are covered with a satisfactory stand of grass, as determined by the Engineer, is achieved.

3.5 CLEANUP AND PROTECTION

A. During landscape work, store materials and equipment where directed. Keep pavements clean and work area in an orderly condition.

B. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers. Maintain protection during installation and maintenance periods.

C. Remove all rubbish, equipment and rejected materials from the Site.

D. Protection includes all temporary fences, barriers and signs and other work incidental to proper maintenance.

3.6 INSPECTION AND ACCEPTANCE

A. When the Work is completed, including maintenance, the Engineer will make an inspection to determine acceptability.

B. Where inspected Work does not comply with the requirements, replace rejected Work and continue specified maintenance until reinspected by the Engineer and found to be acceptable.

++ END OF SECTION ++

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SECTION 02502

TESTING OF WATER DISTRIBUTION SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Furnish all labor, materials, equipment and incidentals required for testing of pipe, casting, fittings, valves and accessories.

1.2 REFERENCES

A. American Water Works Association, AWWA C600, AWWA Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.

1.3 SUBMITTALS

A. List of equipment and personnel to be used for the pressure test.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 TESTS REQUIRED

A. On completion of the pipeline, fill pipeline with water and test. Draw water from the existing water system under the direction of the Engineer and the Water Department.

B. Run pressure test and leakage test simultaneously in accordance with ANSI/AWWA C600. Test pressure shall be not less than 1.25 times the working pressure at the highest point along the test section. Test pressure shall not exceed pipe or thrust restraint design pressure. The hydrostatic test shall be of at least 2 hour duration or until such time as the Engineer indicates acceptance of the pipeline. Test pressure shall not vary by more than ± 5 psi for the duration of the test.

C. On pipelines where the elevation along the route of construction varies substantially, the Engineer reserves the right to valve off and test portions of the line.

D. On extensive construction jobs, the Engineer reserves the right to require the testing of individual portions of the line as construction proceeds rather than await completion of the entire project in order to undertake a pressure of leakage test.

E. Do not operate valves in either direction at differential pressure exceeding the rated valve working pressure. Use of a test pressure greater than the rated valve pressure can result in trapped test pressure between the gates of a double-disk gate valve. For tests at these pressures, the test setup should include provision, independent of the valve, to reduce the line pressure to the rated valve pressure on completion of the test. The valve can then be opened enough to equalize the trapped pressure with the line pressure, or fully opened if desired.

F. Test pressure shall not exceed the rated pressure of the valves when the pressure boundary of the test section includes, closed, resilient-seated gate valves or butterfly valves.

3.2 TIME FOR MAKING TESTS

A. No pipeline is to be placed under pressure or subjected to hydrostatic pressure until at least 5 days have elapsed after the concrete thrust blocks have been installed. If high early strength concrete is used in the concrete thrust blocks, the hydrostatic pressure can be applied to the main after 2 days have elapsed from time of construction of the thrust blocks.

B. The Contractor will be allowed to complete backfilling as hereinbefore specified, prior to undertaking the leakage and pressure tests. Backfilling prior to conducting tests will be at the option of the Contractor with the exception of intersections, driveways, crosswalks and other such locations where holding open the trench may adversely affect the public.

C. Pipelines may be subjected to hydrostatic pressure and inspected for leakage at any convenient time after the trench has been partially backfilled. Partial backfilling shall consist of filling along the center of the pipe length and leaving the joint open for inspection.

3.3 PROCEDURE

A. After the pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure of at least 1.25 times the working pressure at the point of testing. Slowly fill each valved section of pipe with water, and apply the specified test pressure, based on the elevation of the highest point of the line or section under test and corrected to the elevation of the test gauge by means of a pump connected to the pipe in a manner satisfactory to the Engineer. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure. The system shall be stabilized at the test pressure before conducting the leakage test.

B. Do not operate any valve or other control device on the existing water system for any purpose. Do not make any tap or cut-in to the existing water system without the approval of the Engineer and unless an authorized representative of the Owner is present.

C. When the Contractor's operations require the adjustment of any hydrant, valve, or other control device on the existing system, the Owner will provide authorized personnel for the purpose of supervising the operation of these control devices. The Contractor shall provide the personnel for the operation of these devices.

D. Conduct connections to the existing system under the direction of the Owner's Project Representative.

E. To allow for proper filling, venting, testing, etc., install any corporation stops and/or special fittings which may be required. All such installations shall be subject to the approval of the Owner's Project Representative.

F. Foreign materials left in the pipeline during installation often results in valve or hydrant seat leakage during the pressure test. Thorough flushing is recommended prior to a pressure test by partially opening and closing valves and hydrants several times under expected line pressure, with flow velocities adequate to flush foreign material out of the main, valves and hydrants.

G. Before applying the specified test pressure, expel air completely form the pipe, valves, and hydrants. If permanent air vents are not located at all high points, install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, close the corporation cocks and apply the test pressure. At the conclusion of the pressure test, either remove and plug or leave in place the corporation cocks at the discretion of the Owner.

3.4 EXAMINATION UNDER PRESSURE

A. Examine exposed pipes, fittings, valves, hydrants, and joints carefully during the test.

B. Repair or replace any cracked or defective pipe, fittings, valves, hydrants, or joints that are discovered following the pressure test with sound material, and repeat the test until it is satisfactory to the Engineer.

3.5 LEAKAGE TEST

A. Leakage is defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof to maintain pressure after the pipe has been filled with water and the air has been expelled. Testing shall include all hydrants and hydrant branches. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

B. No pipe installation will be accepted if the leakage is greater than that determined by the following formula; or greater than 10 gallons per inch diameter per mile per 24 hours, whichever is less:

$$L = \frac{SD\sqrt{P}}{5550}$$

where: L = allowable leakage (gpd)
S = length of pipe tested (ft)
D = nominal diameter of pipe (in.)
P = average test pressure during the leakage test (psig)

This formula is based on an allowable leakage of 12.03 gpd/mi/in. of nominal diameter at a pressure of 160 psi.

C. When testing against closed metal seated valves, an additional leakage per closed valve of 0.0078 gph/in of nominal valve size will be allowed.

D. When hydrants are in the test section, the test shall be made against the closed main valve in the hydrant.

E. Acceptance will be determined on the basis of allowable leakage. If any test of laid pipe discloses leakage greater than that specified in this section, locate and make approved repairs as necessary until the leakage is within the specified allowance at no additional cost to the Owner.

F. Visible leaks are to be repaired, regardless of the amount of leakage.

+ + END OF SECTION + +

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SECTION 02529

CONCRETE CURBS, GUTTERS AND SIDEWALKS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install concrete curbs, gutters and sidewalks.
   2. Types of Work covered by these Specifications are conventionally formed or machine formed curbs, gutters and sidewalks.
   3. Thickness and extent of curbs, gutters and sidewalks are shown on the Drawings.

B. Related Sections:
   1. Section 02200, Earthwork.
   2. Section 02500, Pavement.
   3. Section 03200, Concrete Reinforcing
   4. Section 03251, Concrete Accessories
   5. Section 03300, Cast-In-Place Concrete.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM D1190, Concrete Joint Sealer, Hot Poured Elastic type.

B. Applicator Qualifications: Minimum of two years installing curbs, gutters and sidewalks.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Samples, manufacturer's product data, test reports and material certifications as required in referenced Sections for concrete work.

B. Certificates: Submit for approval the following:
   1. Manufacturer's certification that sealer meets Specification requirements.

C. Shop Drawings: Submit for approval the following:
   1. Copies of dimensioned layout of the Work, showing pattern, expansion joints and reinforcing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars and Welded Wire Fabric: Deformed steel bars and smooth wire fabric shall comply with requirements of Section 03200, Concrete Reinforcing.
   1. Furnish wire fabric in flat sheets, not rolls.

B. Concrete Materials: Comply with requirements of applicable Division 03 - Concrete Work Sections for formwork, concrete materials, admixtures, bonding materials, curing materials and others as required.

C. Expansion Joint Material: Comply with requirements of Section 03251, Concrete Accessories, for preformed expansion joint fillers.

2.2 CONCRETE MIX, DESIGN AND TESTING

A. Comply with requirements of applicable provisions of Section 03300, Cast-In-Place Concrete, for concrete mix designs, sampling and testing, and quality control.

B. Design the mix to produce concrete having properties of compressive strength, slump range and air content as specified in Section 03300.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

A. Preparation of the subgrade including compaction shall be completed for the full width of the Work:
   1. The Contractor and his installer shall examine the substrate and the conditions under which Work is to be performed and notify the Engineer of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.
   2. Verify that earthwork is completed to correct line and grade.
   3. Do not commence Work until conditions are satisfactory and approved by the Engineer.
   4. Where the subgrade is constructed by excavation of existing grade, the top 6-inches of the subgrade shall be compacted to at least 90 percent of maximum density at optimum moisture content.
   5. Where the subgrade is constructed on fill:
      a. The existing grade shall be made smooth and compacted per Section 3.1.A.
      b. The subgrade shall be brought to the final lines and grades utilizing select fill as specified in Section 02200, Earthwork. The compaction requirements of Section 02200 apply.
   6. Base: Base shall be provided as shown on the Drawings. The material shall be select fill as specified in Section 02200, Earthwork, and compacted as specified.

3.2 FORM CONSTRUCTION

A. Set forms to line and grade. Install forms over full length of curbs, gutters and sidewalks.

3.3 REINFORCEMENT

A. Locate, place, and support reinforcement as specified in Section 03200, unless otherwise shown. Size of reinforcement shall be as shown.

3.4 CONCRETE PLACEMENT

A. General: Comply with the requirements of Section 03300 for mixing and placing concrete, and as specified.

B. Place concrete for curbs and gutters using methods which prevent segregation of the mix. Consolidate concrete along the face of forms with an internal vibrator.

C. For sidewalks, place concrete in one course, monolithic construction, for the full width and depth of walks.

D. Machine Formed: Automatic curb, gutter and sidewalk machine may be used for forming, at the Contractor's option. Concrete shall have properties as specified in Section 03300, except that

maximum slump shall be 2-1/2 inches and air content shall be 2 percent of design. Machine forming shall produce curbs, gutters and sidewalks to the required cross-section, lines, grades, finish, and jointing, as specified for conventionally formed concrete. If results are not acceptable, remove and replace at the Contractor's expense.

3.5 JOINTS

A. General: Construct expansion, contraction, and construction joints with faces perpendicular to surface of the curb, gutter and sidewalk. Construct transverse joints at right angles to the Work centerline and as shown.

B. Contraction Joints: Provide these joints at 10 feet on centers for curbs and gutters and 5 feet on centers for sidewalks.

C. Construction Joints: Place joints at locations where placement operations are stopped for a period of more than 1/2-hour, except where such pours terminate at expansion joints.

D. Expansion Joints: Provide 1/2-inch expansion joint filler where Work abuts structures; at returns; and at 30 foot spacing for straight runs. If curb, gutter, and sidewalk are not poured monolithically, provide expansion joints where each abuts the other.
   1. Place top of expansion joint material not less than 1/2 inch or more than 1 inch below concrete surface. Apply joint sealer on top of expansion joint material flush with concrete surface, and in accordance with manufacturer's instructions.

3.6 CONCRETE FINISHING

A. Smooth the exposed surface by screeding and floating.

B. Work edges of gutter and sidewalks, back top edge of curb, and transverse joints; and round to 1/4-inch radius.

C. Complete surface finishing by drawing a fine-hair broom across surface, perpendicular to line of traffic.

3.7 CURING

A. Protect and cure finished concrete curbs, gutters and sidewalks, complying with applicable requirements of Section 03300.

3.8 REPAIR AND CLEANING

A. Repair or replace broken or defective curbs, gutters and sidewalk as directed by the Engineer.

B. Sweep Work and wash free of stains, discolorations, dirt or other foreign material.

++ END OF SECTION ++

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SECTION 02576

PAVEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install hot mix-hot laid bituminous paving. In addition, any existing pavement damaged by the Contractor outside the removal limits shown on the Drawings shall be removed and replaced, as directed by the Engineer.
   2. The Work includes permanent and temporary pavements comprised of one or more of the following:
      a. Aggregate base course.
      b. Tack coats.
      c. Binder course.
      d. Top course.
      e. Pavement marking.
   3. Temporary pavement shall be placed as necessary.
   4. In order to prevent damage to the permanent pavement by the Contractor's operations, all permanent pavement materials, including the aggregate base course, shall not be installed until approved in writing by the Engineer. The finished course of paving shall not be installed until all buildings, structures, equipment, piping and outside facilities are substantially completed and at a time approved by the Engineer.

B. Related Sections:
   1. Section 02050, Demolition, Removals and Modifications.
   2. Section 02200, Earthwork.
   3. Section 02529, Concrete Curbs, Gutters and Sidewalks.

1.2 QUALITY ASSURANCE

A. Plant Inspection: All bituminous mixes will be subject to inspection, testing and approval by the Owner. The Contractor and plant personnel shall furnish all necessary assistance and cooperation.

B. Laboratory Approval: Laboratory approval of the sources of supply of the fine aggregates, coarse aggregates, mineral filler, bituminous materials, liquefiers and any other materials used in the mix shall be obtained and submitted by the Contractor. No delivery or mixed materials shall be made from any bituminous mixing plant until the source of supply are approved.

C. Testing Services:
   1. General: Testing of materials and of compaction requirements for compliance with technical requirements of the Specifications shall be the duty of the testing laboratory provided by the Owner.
   2. Testing Services: The testing laboratory will:
      a. Test the Contractor's proposed materials in the laboratory and field for compliance with the Specifications.
      b. Perform field density tests to assure that the specified compaction of surface and base course materials has been obtained.
      c. Report all test results to the Engineer and the Contractor.
   3. Authority and Duties of Testing Laboratory: Technicians representing the testing laboratory will inspect the materials in the field and perform compaction tests, and will report their findings to the Engineer and the Contractor. When the materials furnished or work performed by

the Contractor fails to fulfill Specifications requirements, the technician will direct the attention of the Engineer and the Contractor to such failure.

a. The technician will not act as foreman or perform other duties for the Contractor. Work will be checked as it progresses, but failure to detect any defective work or materials shall not in any way prevent later rejection when such defect is discovered, nor will it obligate the Engineer for final acceptance. Technicians are not authorized to revoke alter, relax, enlarge, or release any requirements of the Specifications, nor to approve or accept any portion of the Work.

4. Responsibilities and Duties of the Contractor: The use of testing services shall in no way relieve the Contractor of his responsibility to furnish materials and construction in full compliance with the Drawings and Specifications. To facilitate testing services, the Contractor shall:
   a. Secure and deliver to the Engineer and the testing laboratory representative samples of the materials they propose to use and which are required to be tested.
   b. Furnish such casual labor as is necessary to obtain and handle samples at the project or at other sources of material.
   c. Advise the testing laboratory and the Engineer sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.

D. Reference Standards: Comply with the applicable provisions and recommendations of the following, unless otherwise shown or specified.
   1. Standard Specifications and Drawings (including addenda) of the County of Nassau Department of Public Works for Construction of Highway and Bridges, herein referred to as the County Standard Specification.
      a. Bituminous concrete shall conform to the County Standard Specification, Part Three, Section B.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. At least two weeks prior to the date of anticipated use, the Contractor shall submit to the Owner for approval, a representative sample of materials for the following:
      a. Aggregate base course.
      b. Binder course.
      c. Top course.
      d. Other materials as requested by the Engineer.
   2. The Contractor shall notify the Owner in writing of the location and source of each sample.

B. Shop Drawings: Submit for approval the following:
   1. Job mix formula proposed, giving complete data on materials, including source, location, percentages, temperatures, date of last testing, and all other pertinent data.

1.4 JOB CONDITIONS

A. Weather Limitations:
   1. Permanent paving materials, including the aggregate base course, shall be placed only when the air temperature is 40 degrees Fahrenheit and rising or warmer and the surface on which the paving is to be laid is 40 degrees Fahrenheit or higher. All temperatures are to be measured in the shade.
   2. Bituminous pavement for temporary uses, that are not and will not become part of a permanent pavement, will not be subject to the above regulations in regard to weather limitations. No pavement, however, shall be laid on a frozen subgrade.

B. Grade Control: Establish and maintain the required lines and grades, including crown and cross-slope for each course during construction operations.

PART 2 – PRODUCTS

2.1 PAVEMENT THICKNESS

A. In-place compacted material thickness shall not be less than shown on the Drawings.

2.2 MATERIALS

A. Materials shall conform to the following:
   1. Subgrade shall be virgin material or select fill conforming to the requirements of Section 02200, Earthwork.
   2. Base Courses:
      a. Aggregate for permanent pavement base course shall consist of crushed stone conforming to the requirements of the County Standard Specification and the following gradation:

Screen Size	% Passing
1-1/2-in	100
1-in	90-100
1/2-in	65-85
3/8-in	55-75
#4	40-55
#8	30-45
#16	22-36
#30	16-27
#50	12-19
#100	7-13
#200	3-8

      b. Aggregate for temporary access road base course shall consist of limestone screenings. Stone screenings shall be limestone and may be crusher run provided 100 percent passes a 1/2-inch screen, 15 percent to 35 percent passes a #20 screen and 5 percent passes a #200 screen. Screenings need not be washed provided they contain no clay, loam or other deleterious material. Screenings shall be from stone that passes the abrasion and soundness tests described under the County Standard Material Specification M4 Coarse Aggregate.
   3. Pavement:
      a. Permanent: Provide a two course wearing surface for permanent pavement, consisting of a binder course and a top course. Binder course shall conform to the County Standard for Bituminous Concrete Binder Course. Top course shall conform to the County Standard for Bituminous Concrete Type 1A (Flat Process) Top Courses.
      b. Temporary: Provide a one course-wearing surface for temporary pavement, consisting of a top course as specified above.
   4. Tack Coat: Tack coat shall be an asphalt emulsion conforming to the County Standard Material Specification M5 Bituminous Materials, Material Designation RS-1.
   5. Pavement Markings: Pavement markings shall be installed at locations shown on the Drawings. Pavement markings shall be white, thermoplastic reflectorized type conforming to Section 727-01 of the New York State Department of Transportation, Design and Construction Division, Standard Specifications, Construction and Materials, latest revision.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation of all pavement materials and pavement markings shall be performed by experienced personnel.

B. Preparing the mixtures, paving equipment, placing the mixes, and compacting the mixes shall be in accordance with the County Standard Specification.
   1. Preparing the mixtures includes the plant equipment, stockpiling, heating, aggregate processing, mixing of aggregate and bituminous material, and transportation to job site.
   2. Paving equipment includes bituminous pavers, rolling equipment and hand tools.
   3. Placing the mixes includes paver-placing, hand placing, spreading, tamping and jointing.
   4. Compacting the mixes includes breakdown rolling, second rolling and finish rolling.

C. Regardless of the type of temporary or permanent restoration involved, the Contractor shall insure that all castings are set flush with the road surface. The Contractor is advised that there shall be no placement of bituminous concrete top course until:
   1. Curbs, gutter aprons, driveway aprons, surface inlets, catch basins, and manholes have been constructed to their final elevation.
   2. Defective areas of the binder course have been repaired.

D. Provide final surfaces of uniform texture, conforming to required grades and cross sections.

E. Repair holes from test specimens as specified for patching defective work.

F. The Contractor shall provide all labor, equipment and materials required to provide a drainage system for temporary access roads to facilities under construction.

3.2 SUBGRADE PREPARATION

A. Permanent Pavement: Preparation of the permanent pavement subgrade including compaction shall be completed for the full width of the roadway.
   1. Fine grade earth subgrade and compact with self-powered rollers of sufficient size to provide a firm, unyielding surface to receive the aggregate base course. Remove and replace all un-suitable subgrade material as directed by the Engineer.
   2. Where the subgrade is constructed by excavation of the existing grade, the top 6-inches of the subgrade shall be compacted to at least 95 percent of maximum density at optimum moisture content as determined in ASTM D 698.
   3. When the subgrade is constructed on fill:
      a. Existing grade shall be made smooth and compacted per Section 3.2.A.2.
      b. Subgrade shall be brought to the appropriate lines and grades utilizing select backfill placed in accordance with the applicable requirements of Section 02200, Earthwork.
   4. Existing grades prior to placement of subbase or backfill shall be established such that when materials for construction are placed no rutting or displacement will occur.

B. Temporary Pavement: Subgrade shall be compacted with a ten-ton roller or other approved method.

C. No materials, temporary or permanent, shall be placed on subgrades which are muddy or have water thereon.

3.3 PERMANENT PAVEMENT BASE COURSE INSTALLATION

A. Construct base course to thickness shown on Drawings in equal layers not more than three inches (compacted) thick. If subgrade material is worked into the base material during compaction or finishing operations, remove the aggregate over this area and replace with new aggregate.

B. Compact each layer with a power driven roller weighing not less than ten tons in an approved manner with the aid of water. Before mixing and spreading the base material, the moisture content shall be both sufficient to prevent segregation into pockets of fine and coarse material, and to permit satisfactory compaction. Add water as required.

C. After compaction, the top surface of this course shall not extend above, nor more than 1/2-inch below true grade and surface at any location. Depressions shall be filled with additional aggregate material and the surface rerolled. Base course shall be maintained by the Contractor within the 1/2-inch tolerance until the pavement course is installed.

3.4 LIMESTONE SCREENINGS INSTALLATION

A. Construct limestone screenings course to not less than 4-inch thickness.

B. Screenings shall be spread evenly and thoroughly rolled with an approved three-wheel roller, weighing not less than 10 tons, until thorough consolidation is obtained. Depressions shall be filled with screenings, and the process of rolling and filling shall continue until a thoroughly compacted uniform surface, satisfactory to the Engineer, is produced. No segregation of large or fine materials will be permitted, but the screenings shall be sprinkled with water at times and in the amounts necessary to provide consolidation.

3.5 PAVEMENT INSTALLATION

A. Contact surfaces of all curbings, gutters, castings and adjacent pavement edges shall be painted with a layer of tack coat before placing or repairing the pavement course.

B. Bituminous concrete shall be constructed to thicknesses as shown on the Drawings and rolled with 12 ton self powered two axle or three-axle tandem or three-wheel roller to a density of 94 percent of maximum.

C. Pavement shall be uniform in appearance, free of bumps and hollows, worked to drain, and free of bleeding.

D. Trim the existing pavement with pneumatic chisels of all loose edges and broom and tack coat all edges prior to placing the transition pavement.

E. In placing and compacting abutting courses of bituminous concrete pavements, joint heating devices shall be used on all joints (transverse, longitudinal and existing). See the County Standard Specification for additional information.

F. Bituminous pavement shall match in thickness the existing pavement and shall butt with the pavement in a smooth, even transition.

G. Test bituminous pavement for conformity with the specified crown and grade immediately after initial compression. Correct variations by the removal or additional of materials and by continuous rolling.

H. The finished surface shall not vary more than 1/4-inch when tested with a 16-ft straightedge applied parallel with, or at right angles to, the centerline.

I. After final rolling, again test the smoothness of the course. Correct humps or depressions exceeding the specified tolerances or that retain water on the surface by removing the defective work and replacing with new material.

3.6 TEMPORARY PAVEMENT OVER TRENCHES

A. Bituminous concrete plant mix to be utilized for temporary pavement over trenches, as required, shall conform to the requirements for the top course Type 1A plant mix conforming to the Referenced Specifications.

B. Trenches for utility work within existing paved areas shall receive temporary pavement. Temporary pavement shall be furnished, installed and maintained by Contractor. The Owner shall determine the limits of temporary pavement to be installed over these trenches.

C. After the trench has been properly backfilled, excavation shall be made over the trench area and the sub-grade compacted by rolling with a ten ton roller or other approved methods, so as to permit the placing of a one and one-half inch (1-1/2") compacted thickness of bituminous concrete. The sub-grade shall not be in a muddy or frozen condition and shall be smooth and parallel to the desired surface of the finished pavement. Compaction of this 1-1/2" minimum thickness bituminous concrete shall be as specified herein.

3.7 PATCHING

A. Remove and replace all defective areas in temporary and permanent pavements. Cutout such areas and fill with fresh Type 1A bituminous concrete top course as specified in the County Standard Specification. Compact to the required density.

3.8 CLEANING AND PROTECTION

A. After completion of paving operations, clean surfaces of excess or spilled bituminous materials and all foreign matter.

B. Protect newly finished pavement until it has become properly hardened by cooling.

C. During the paving operation cover openings of drainage structures in the area of paving.

3.9 MAINTENANCE AND ACCEPTANCE

A. The Contractor shall maintain all paved surfaces until the roads and parking areas have been accepted. Paved areas will not be accepted until after the Contractor has completed all phases of the work, including all necessary transportation, hauling and severe usage of the paved areas. The Engineer shall be the sole judge in this matter.

+ + END OF SECTION + +

SECTION 02653

DISINFECTION OF WATER UTILITY PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Disinfection of potable water distribution systems.
   2. Testing and reporting of results.

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA B300 - Hypochlorites.
   2. AWWA B302 - Ammonium Sulfate.
   3. AWWA B303 - Sodium Chlorite.
   4. AWWA C651 - Disinfecting Water Mains.

1.3 SUBMITTALS

A. Manufacturer’s installation instructions shall be provided along with product data.

B. Submittals shall be provided in the order in which they are specified and tabbed (for combination submittals).

C. Disinfection Procedure:
   1. Submit description of procedure to the Director’s Representative for review/approval, including type of disinfectant and calculations indicating quantities of disinfectants required to produce specified chlorine concentration.

D. Product Data: Submit manufacturer information for proposed chemicals and treatment doses.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Certify that final water complies with disinfectant quality standards of the New York State Department of Health.

G. Test and Evaluation Reports: Indicate testing results comparative to specified requirements.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

I. Qualifications Statements:
   1. Submit qualifications for manufacturer and applicator.

1.4 CLOSEOUT SUBMITTALS

A. Disinfection Report:

   1. Type and form of disinfectant used.
   2. Date and time of disinfectant injection start and completion.
   3. Test locations.
   4. Name of person collecting samples.
   5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
   6. Date and time of flushing start and completion.
   7. Disinfectant residual after flushing (in ppm) for each outlet tested.

1.5 QUALITY ASSURANCE

A. Perform Work according to AWWA C651. Do not use the Tablet Method therein.

B. Comply with all requirements of the New York State Department of Health for disinfection of potable water lines, valves, hydrants, and appurtenances.

PART 2 - PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Chemicals:
   1. Hypochlorite: Comply with AWWA B300.
   2. Ammonium Sulfate: Comply with AWWA B302.
   3. Sodium Chlorite: Comply with AWWA B303.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that piping system has been cleaned, inspected, and pressure tested prior to disinfection.

B. Verify that access fittings have been installed under Section 331416 - Site Water Utility Distribution Piping.

C. Perform scheduling and disinfecting activity with startup, water pressure testing, adjusting and balancing, and demonstration procedures, including coordination with related systems.

3.2 INSTALLATION

A. Provide required equipment to perform Work of this Section.

B. Introduce treatment into piping system.

C. Maintain disinfectant in system for 24 hours.

D. Flush, circulate, and clean until required disinfectant quality standard has been achieved using city water.

E. Replace permanent system devices that were removed for disinfection.

3.3 FIELD QUALITY CONTROL

A. Disinfection, Flushing, and Sampling:
   1. Disinfect pipeline installation according to AWWA C651.
   2. Use of liquid chlorine is not permitted.
   3. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
   4. Disposal:
      a. Discharge super chlorinated water in a manner that will not adversely affect plants and animals. Comply with applicable State regulations for waste discharge.
      b. A neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.
   5. After final flushing and before pipeline is connected to existing system or placed in service, disinfection, and subsequent bacteriological tests must be completed, and approval must be obtained by the New York State Department of Health.
   6. Bacteriological Tests: Coordinate with Director's Representative for sampling criteria and procedures.
      a. Test water main for bacteriological quality before putting pipe into service. A minimum of two successive sets of samples shall be taken at 24-hour intervals. Both sets of samples shall indicate bacteriological safe water, and approval must be obtained by the Director's Representative before putting the system in operation. Pay all expenses incurred for testing.
      b. Tests shall be conducted by a laboratory approved by the New York State Department of Health.
   7. Give all test results to Director's Representative.

a. Should test results prove any part of the system bacteriologically unsafe, repeat disinfection procedures until satisfactory results are obtained.
b. Obtain written approval from the Director's Representative/New York State Department of Health prior to bringing water system online.

+ + END OF SECTION + +

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SECTION 03100

CONCRETE FORMING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete forming. The Work also includes:
      a. Designing forming systems in accordance with requirements of ACI 301 and ACI 350.5 and the Contract Documents.
      b. Providing forming to accommodate the Work under this and other Sections and building into forming items such as sleeves, anchorage devices, inserts, pipe embedment, reinforcing, and all other items to be embedded in concrete for which placement is not specifically provided under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before concrete forming Work.
   2. Coordinate forming Specifications with requirements for finished surfaces specified in Section 03300, Cast-In-Place Concrete.

C. Related Sections:
   1. Section 03251, Concrete Accessories.
   2. Section 03300, Cast-In-Place Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 117, Specifications for Tolerances for Concrete Construction and Materials and Commentary.
   2. ACI 301, Specifications for Structural Concrete.
   3. ACI 350.5, Specifications for Environmental Concrete Structures.
   4. ASTM C805/C805M, Test Method for Rebound Number of Hardened Concrete.
   5. ASTM C1074, Practice for Estimating Concrete Strength by the Maturity Method.
   6. NIST PS 1, Structural Plywood.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Professional Engineer:
      a. Contractor or formwork Supplier shall retain a licensed design engineer legally qualified to practice in same state as the Site. Licensed design engineer shall have at least five years experience designing formwork and falsework of the type required.
      b. Responsibilities include:
         1) Reviewing formwork and falsework performance and design criteria stated in the Contract Documents.
         2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
         3) Preparing or supervising preparation of design calculations verifying compliance of formwork and falsework with requirements of the Contract Documents.
         4) Signing and sealing calculations.
         5) Certifying that:

a) Design of formwork and falsework was performed in accordance with performance and design criteria stated in the Contract Documents, and
b) Design conforms to Laws and Regulations, and to prevailing standards of practice.
c) In place falsework, prior to concrete placement, complies with the intent of the forming design and complies with the Contract Documents.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Samples:
      a. Plywood form material used for smooth form finish, four inches square minimum.

B. Informational Submittals: Submit the following:
   1. Shop Drawings: When requested by Engineer, submit Shop Drawings showing and indicating general construction of individual forms, including:
      a. Jointing.
      b. Special formed joints or reveals.
      c. Location, pattern, and details of form tie placement, removal, and repair procedures.
      d. Location and details for temporary openings.
      e. Void-form layout drawings and details of installation.
      f. Other items that would visually affect the finished concrete.
   2. Design of Temporary Measures: Design of formwork and falsework is Contractor's responsibility. Submit the following:
      a. Falsework layout drawings with the seal and signature of Contractor's or Supplier's licensed design engineer. Layout drawings shall show bracing details, waler arrangements, location of shores, joint forming details, and details at connections to previously placed concrete. Engineer's review will be for general conformance to the requirements of the Contract Documents and ACI 301 and ACI 350.5, as indicated for delegated design in the General Conditions.
      b. Design calculations for formwork and falsework, when requested by Engineer.
      c. Certification letter from Contractor's or Supplier's licensed design engineer stating that in-place falsework was inspected and complies with the intent of the falsework design.
   3. Product Data: Manufacturer's data for proprietary materials, including form coatings, manufactured form systems, ties and accessories.
   4. Manufacturer's Instructions: Installation instructions for proprietary materials, including form coatings, manufactured form systems, ties and accessories.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Storage:
   1. Upon delivery to the Site, place materials in area protected from weather.
   2. Store materials in accordance with manufacturer's recommendations.
   3. Store materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective, waterproof covering. Provide for adequate air circulation or ventilation under cover.

B. Handle materials in accordance with the manufacturers' recommendations. Do not damage materials during handling.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria:
   1. Design, erect, support, brace and maintain forming in accordance with ACI 301 and ACI 350.5 so that forming safely supports vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by forming system or in-place construction that has attained adequate strength for the purpose. Construct forming so that concrete members and structures are of correct size, shape, alignment, elevation, and position.
   2. Design forms and falsework to include values of live load, dead load, weight of moving equipment operated on forming, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
   3. Provide shores and struts with positive means of adjustment capable of taking up forming settlement during concrete placing operations, using wedges or jacks, or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.
   4. Support form facing materials by structural members spaced sufficiently close to prevent beyond tolerance deflection, in accordance with ACI 117. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances. For long-span members without intermediate supports, provide camber in forming as required for anticipated deflections resulting from weight and pressure of fresh concrete and construction loads.
   5. Design and construct forming to be readily removable without impact, shock or damage to concrete surfaces and adjacent materials.
   6. Provide forming sufficiently tight to prevent leakage of cement paste during concrete placing. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

2.2 FORM MATERIALS

A. Forms for Smooth Finish Concrete:
   1. Unless otherwise shown or indicated in the Contract Documents, construct forming for smooth concrete surfaces with plywood, metal, metal-framed plywood-faced, or other panel type materials acceptable to Engineer, to provide continuous, straight, smooth as-cast surfaces with no wood grain or other surface texture imparted by forming. Provide in largest practical sizes to minimize number of joints and to conform to joint system shown or specified in the Contract Documents. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

B. Forms for Standard Finish Concrete:
   1. Form concrete surfaces designated to have standard formed finish with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least two edges and one side.

C.. Cylindrical Columns and Supports:
   1. Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant type adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.
      a. Provide manufacturer's seamless units to minimize spiral gaps or seams.
   2. Fiberglass or steel forms may be used for cylindrical columns if accepted by Engineer in writing.

D. Form Ties:
   1. Provide factory-fabricated metal form ties, designed to prevent form deflection, and to prevent spalling of concrete surfaces upon removal.
   2. Unless otherwise shown or indicated in the Contract Documents, provide ties so that portion of tie remaining within concrete after removal of exterior parts of tie is at least 1.5 inches from the outer concrete surface. Unless otherwise shown or indicated in the Contract Documents, provide form ties that will leave a hole no larger than one-inch diameter in concrete surface.
   3. Ties shall have waterstops on exterior, below-grade walls, and walls subject to hydrostatic pressure.
   4. Ties shall leave a uniform, circular hole when forms are removed.
   5. Do not use removable ties unless accepted by Engineer. Removable ties are not allowed on exterior below-grade walls or walls subject to hydrostatic pressure. If removable ties are accepted, Contractor shall submit hole repair details for Engineer approval.
   6. Wire ties are not allowed.
   7. Do not use reinforcing bars shown by the Drawings as part of the form tie system unless approved by Engineer.
   8. Provide stainless steel form ties for areas with architectural finish. When used, tiebreak back point shall be at least one inch from outer concrete surface.

E. Form Coatings:
   1. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compounds. For concrete surfaces that will be in contact with potable water or water that will be treated to become potable, form coating shall be a mineral oil base coating.

F. Void-Forms:
   1. Void (carton) forms shall be corrugated fiberboard used for creating a void space beneath grade beams and slabs on grade.
   2. Manufacturer: Provide void-forms by one of the following:
      a. Savway Carton Forms
      b. Sheplers
      c. SureVoid Products
      d. Or equal
   3. Void-forms shall have moisture-resistant treated paper faces, be laminated with waterproof adhesive, and be biodegradeable. Void-forms shall have interior fabrication of uniform braced cellular configuration and shall be capable of sustaining minimum working load of 1,000 psf for minimum of ten days after concrete placement.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine substrate and conditions under which the Work will be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 FORM CONSTRUCTION

A. Construct forms in accordance with ACI 301 and ACI 350.5; to the exact sizes, shapes, lines, and dimensions shown; as required to obtain accurate alignment, location, and grades; to tolerances specified; and to obtain level and plumb work in finish structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads,

anchorages and inserts, and other features required. Use selected materials to obtain required finishes. Finish shall be in accordance with approved mock-up or sample panel, when specified.

B. Allowable Tolerances:
   1. Construct forming to provide completed concrete surfaces complying with tolerances specified in ACI 117 and as follows:
      a. Architectural finish forming, and where shown or indicated on the Drawings, shall be Class A surface, 1/8-inch offset.
      b. Other surfaces exposed to view shall be Class B surface, 1/4-inch offset. Exposed to view shall include surfaces of liquid containing structures when liquid and media, if present, are removed.
      c. Other surfaces shall be Class C surface, 1/2-inch offset.
   2. Tolerances apply to form offsets and to irregularities within the formed surface when measured with a straightedge over a five-foot distance.

C. Install forming and accessories for facilities in accordance with manufacturer's instructions, Laws and Regulations, and the Contract Documents.

D. Fabricate forms for easy removal without damaging concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.

E. Provide temporary openings where interior area of forming is inaccessible for cleanout, for inspection before concrete placement, and for placing concrete. Brace temporary closures and set tightly to forms to prevent loss of cement paste. Locate temporary openings on forms in locations as inconspicuous as possible, consistent with requirements of the Work. Form intersecting planes of openings to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.

F. Falsework:
   1. Erect falsework and support, brace, and maintain falsework to safely support vertical, lateral, and asymmetrical loads applied until such loads can be supported by in-place concrete structures. Construct falsework so that adjustments can be made for take-up and settlement.
   2. Provide wedges, jacks or camber strips to facilitate vertical adjustments. Carefully inspect falsework and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure; make necessary adjustments to produce finished Work of required dimensions.

G. Forms for Smooth Finish Concrete:
   1. Do not use metal cover plates for patching holes or defects in forms.
   2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
   3. Use extra studs, walers, and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material that will produce bow.
   4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.
   5. Form molding shapes, recesses, rustication joints and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

H. Corner Treatment:

1. Form exposed corners of beams, walls, foundations, bases and columns to produce smooth, solid, unbroken lines, except as otherwise shown or indicated in the Contract Documents. Chamfer exposed corners.
2. Form chamfers with 3/4-inch by 3/4-inch strips, unless otherwise shown or indicated in the Contract Documents, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Use rigid PVC chamfers for architecturally formed concrete. Extend terminal edges to required limit and miter chamfer strips at changes in direction.
3. Reentrant or internal and unexposed corners may be formed either square or chamfered.

I. Joints:
1. For joint treatment, comply with Section 03251, Concrete Accessories. Locate joints as shown and specified.

J. Openings and Built-In Work:
1. Provide openings in concrete forming shown or required under other Sections. Refer to Paragraph 1.1.B of this Section for coordination requirements.
2. Accurately place and securely support items to be built into forms.

K. Sealing Forming:
1. Forming joints shall be tight-fitting or otherwise sealed to prevent loss of cement paste.
2. Provide forming resting against concrete surfaces with compressible gasket material between the concrete and edge of form, to fill irregularities and create tight seal.

L. Cleaning and Tightening:
1. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before concrete is placed. Retighten forms immediately after placing concrete, as required to eliminate cement paste leaks.

M. Tie Hole Repair:
1. Repair tie holes in accordance with Section 03300, Cast-In-Place Concrete.

3.3 FORM COATINGS

A. Coat form contact surfaces with non-staining form-coating compound before installing reinforcing materials. Do not allow excess form coating material to accumulate in forms or come into contact with surfaces that will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

B. Coat steel forms with non-staining, rust-preventative form oil, or otherwise protect against rusting. Do not use rust-stained steel forming.

C. For concrete surfaces that will be in contact with potable water or water that will be treated to become potable, form coating shall be mineral-oil base coating.

D. Do not use form coatings on form surfaces covered with CPF liner material.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. Set and build into forming anchorage devices and other embedded items, shown, specified, or required under other Sections. Refer to Paragraph 1.1.B of this Section for coordination requirements. Use necessary setting drawings, diagrams, instructions, and directions.

B. Edge Forms and Screeds Strips for Slabs:

1. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units to support screeds.

3.5 VOID-FORMS

A. Install void-forms where shown or indicated in the Contract Documents, to the thickness indicated, in accordance with manufacturer's recommendations.

B. Where void-form is shown or indicated in the Contract Documents, place void-form to grades and elevations shown over an even, well-compacted subgrade to form continuous void space under entire extent of slab, mat, or grade beam.

C. For structural slab applications, place 1/8-inch thick masonite or plywood sheet over void-form. Place void-forms in largest pieces practical and secure in place.

D. Properly surround and void around upper portion of drilled piers at intersection of slab, grade beam or pier cap using premanufactured, non-field cut sealed void-form with curved, radial, vertical edge adjacent to drilled pier.

E. Void-forms shall remain dry and undamaged prior to concrete placement. Replace damaged pieces prior to placing concrete. Seal all joints and exposed ends to prevent concrete leakage into void space.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Before placing concrete, check ties, tie cones, tie waterstops, embedded items, form coatings, forming stability, alignment, and tolerances. Make corrections and adjustments to ensure forming complies with intent of the forming design, proper stability of forming systems, and accurate size and location of concrete members.
   2. During concrete placing, check forming and related supports to ensure that forms are not displaced and that completed Work will be within specified tolerances.
   3. If forms are unsatisfactory, either before or during concrete placing, stop or postpone placing of concrete until defects are corrected as required by Contractor's or Supplier's professional engineer and accepted by Engineer.

3.7 REMOVAL OF FORMS

A. Determination of time between placing concrete and removing forms and shoring is Contractor's responsibility and shall not be less than that shown in table 03100-A. Requirements specified in this Section are minimum times and requirements intended to ensure that concrete will support its own weight, and do not consider additional effects of the construction. Additional effects of the construction shall be accounted for by Contractor when determining time for removing forming. Time for removing of forms is subject to Engineer's acceptance.

B. Comply with requirements of ACI 301 and ACI 350.5, except as indicated in the Contract Documents.

C. Removal of Forms for Walls, Columns, Sides of Beams and Girders, and Slab and Foundation Edges:
   1. Comply with requirements of Table 03100-A of this Section:

TABLE 03100-A, REMOVAL OF FORMS

Component	Average Daily Ambient Air Temperature (deg F)	Min. Concrete

	Over 70 F	60 F to 70 F	50 F to 60 F	Below 50 F	Compressive Strength for Form Removal
Walls	One day	Two days	Three days	See Para-graph 3.8.C.2 of this Section	750 psi
Columns	Two days	Three days	Four days		1000 psi
Side of beams and girders	One day	One day	Two days		500 psi
Slab and foundation edges	One day	One day	Two days		500 psi

2. When average daily ambient air temperature is below 50 degrees F, do not remove forms until concrete attains minimum compressive strength indicated in Table 03100-A for form removal, and comply with Paragraph 3.8.C.3.b of this Section.
3. Concrete Strength Requirements for Form Removal:
   a. For other than beams and elevated slabs, do not remove forms until concrete attains minimum concrete compressive strength indicated in Table 03100-A for form removal.
   b. For beams and elevated slabs, do not remove supporting forms or shoring until concrete attains minimum of 90 percent of its specified compressive strength.

D. Alternative Criteria for Removing Forms for Walls, Columns, Sides of Beams and Girders, and Slab and Foundation Edges: Contractor has the option of submitting an alternative removal of forms table, together with supporting data, for Engineer's acceptance. Supporting data shall include representative field data for each different placement ambient temperature condition and minimum of three tests per temperature condition to ensure that accurate correlation between concrete strength and placement temperature is obtained.

E. Determination of In-place Concrete Strength:
   1. Determine compressive strength of in-place concrete by compression test specimens cured at the Site under the same conditions of temperature and moisture as the concrete member under consideration.
   2. Alternately, determine compressive strength of in-place concrete by maturity factor procedure in accordance with ASTM C1074 and approved by Engineer. Location of embedded thermistors or thermocouples shall be as approved by Engineer.

F. Leave form facing material in place for minimum of four days after concrete placement, unless otherwise approved by Engineer.

G. Continue curing, including bottom surfaces of slabs and beams, after form removal in accordance with Section 03300, Cast-In-Place Concrete.

3.8 PERMANENT SHORES

A. Provide permanent shores in accordance with ACI 301 and ACI 350.5.

B. Reshores are not allowed.

3.9 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the construction. Do not use split, frayed, delaminated, or otherwise damaged form facing material. Apply form coating compound material to concrete contact surfaces as specified for forming.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joints to avoid offsets. Do

not use “patched” forms for exposed concrete surfaces. Form surfaces are subject to Engineer’s approval.

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SECTION 03200

CONCRETE REINFORCING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete reinforcing.
   2. Extent of concrete reinforcing is shown and indicated in the Contract Documents.
   3. Work includes fabrication and placement of reinforcing including bars, ties, and supports, and welded wire fabric for concrete, encasements, and fireproofing.

B. Related Sections:

   1. Section 03251, Concrete Accessories.
   2. Section 05051, Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 301, Specifications for Structural Concrete.
   2. ACI 350.5, Specifications for Environmental Concrete Structures.
   3. ANSI B212.15, Cutting Tools – Carbide-tipped Masonry Drills and Blanks for Carbide-tipped Masonry Drills.
   4. ANSI/AWS D1.4, Structural Welding Code - Reinforcing Steel.
   5. ASTM A82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
   6. ASTM A1064, Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
   7. ASTM A615, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   8. ASTM A706, Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   9. ASTM A767, Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   10. ASTM A775, Specification for Epoxy-Coated Steel Reinforcing Bars.
   11. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
   12. Concrete Reinforcing Steel Institute (CRSI), CRSI 1MSP, Manual of Standard Practice.
   13. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
   14. ICC Evaluation Service (ES) AC 308, Acceptance Criteria for Post-Installed Anchors in Concrete Elements.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory: Shall meet requirements of ASTM E329 and shall have experience in the testing welded splices of reinforcing steel and tension testing of reinforcing bars set in adhesive in hardened concrete.
   2. Installer of Adhesive Dowels: Shall be experienced and certified by manufacturer of adhesive as possessing necessary training for installing manufacturer's products. Distributors or manufacturer's representatives shall not provide product training unless qualified as certified trainers by anchor manufacturer.

B. Certifications:
   1. Weld Procedures: For types of splices and grades of reinforcing used in the Work, weld procedures for welded reinforcing steel splices shall be certified in accordance with ANSI/AWS D1.4.
   2. Welders: For types of splices and grades of reinforcing used in the Work, welders shall be certified for welding reinforcing steel splices in accordance with ANSI/AWS D1.4.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings for fabricating, bending, and placing concrete reinforcing. Comply with ACI 301 and ACI 350.5.
      b. For walls, show elevations at minimum scale of 1/4-inch to one foot.
         1) Elevations shall show all openings and reference details that identify additional reinforcing required around each opening.
         2) Elevations shall denote each wall intersection and reference a detail that identifies additional reinforcing required at wall intersection. As an alternate to providing separate details for each wall intersection, provide overall plan detailing only the additional wall intersection reinforcing for each wall intersection.
      c. For slabs and mats, show top and bottom reinforcing on separate plan views.
         1) Plans shall show all openings and shall reference details that identify additional reinforcing around each opening.
      d. Show bar schedules, stirrup spacing, diagrams of bent bars, location of bar splices, length of lap splices, arrangements, and assemblies, as required for fabricating and placing concrete reinforcing unless otherwise noted.
      e. Provide plans and elevations detailing location, spacing, and lengths of masonry wall dowels, where masonry is required. Coordinate location of dowels with masonry openings and with standard modular spacing. Submit masonry wall dowels with reinforcing submittal for element into which masonry dowel will be embedded. Coordinate with Section 04201, Unit Masonry Construction.
      f. Splices shall be kept to a minimum. For slabs and beams, when splices are required, locate spices in bottom bars within 1/3 span from supports and for top bars locate splices in the middle 1/3 of the span.
      g. Drawings detailing location of all construction and expansion joints, as required under Section 03251, Concrete Accessories, shall be submitted and approved before Shop Drawings for reinforcing are submitted.
      h. Drawings detailing location, spacing, edge distance, and embedment depth of adhesive dowels. Adhesive system shall be submitted and approved before Shop Drawings with adhesive dowels are submitted.
   2. Product Data:
      a. Manufacturer's product data for adhesive, if not submitted under other Sections.
      b. Adhesive manufacturer's test data and ICC ES report to verify specified capacity of adhesive dowels.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Steel manufacturer's certificates of mill analysis, tensile, and bend tests for reinforcing steel.
      b. Certification of welders and weld procedures for splices.
      c. Adhesive manufacturer's certification verifying that installer is qualified and using proper installation procedures.
   2. Manufacturer's Instructions:
      a. Installation instructions for adhesive systems.
   3. Field Quality Control Submittals:
      a. Reports of all field quality control testing, where applicable.

b. Results of required inspection of welded splices of reinforcing bars.
c. Results of required tensile testing of adhesive dowels. Include size and location of bars tested.

4. Special Procedure Submittals; Description of reinforcing weld locations and weld procedures.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver concrete reinforcing products to Site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings on approved Shop Drawings.

B. Store concrete reinforcing products to prevent damage and accumulation of dirt and excessive rust. Store on heavy wood blocking so that reinforcing does not come into contact with the ground.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars: Shall be deformed in accordance with ASTM A615, and as follows:
1. Provide Grade 60 for all bars, unless indicated otherwise.
2. At beams and columns forming frames and wall boundary elements, where shown on the Drawings, provide ASTM A706 or ASTM A615, Grade 60, with tested actual maximum yield stress of 78,000 psi and ratio of actual tested tensile strength to tested yield strength not less than 1.25.
3. Epoxy-coated reinforcing bars shall be in accordance with ASTM A775.
4. Galvanized reinforcing bars shall be in accordance with ASTM A767.

B. Mechanical Couplers: Reinforcement bars may be spliced with mechanical connection. Connection shall be full mechanical connection that shall develop in tension or compression, as required, at least 125 percent of specified yield strength (fy) of bar. Where splices at the face of wall are shown or approved by Engineer, form saver-type mechanical couplers may be used. Form-saver couplers shall have integral plates designed to positively connect coupler to formwork.

C. Steel Wire: Shall be in accordance with ASTM A82.

D. Welded Smooth Wire Fabric: Shall be in accordance with ASTM A1064.
1. Furnish in flat sheets, not rolls.

E. Column Spirals: Hot-rolled rods for spirals, conforming to ASTM A615.

F. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing in place.
1. Use wire bar type supports complying with CRSI 1 MSP recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
2. For slabs on grade, use precast concrete blocks, four inches square in plan, with embedded tie wire as specified by CRSI 1 MSP. Precast concrete blocks shall have same or higher compressive strength as specified for concrete in which they are located.
3. For concrete surfaces where legs of supports are in contact with forms, provide supports complying with CRSI 1 MSP as follows:
a. At formed surfaces in contact with soil, weather, or liquid, or located above liquid, supports shall be CRSI Class 1 for maximum protection. Plastic coating on legs shall extend at least 0.5-inch upward from form surface. At surfaces not exposed to view or liquid, precast concrete blocks, three inches square in plan, with embedded tie wire shall be permitted. Precast concrete blocks shall have same or higher compressive strength as specified for concrete in which they are located.

b. At interior dry surfaces (not located above liquid), supports shall be either Class 1 or Class 2 for moderate protection.
c. At formed surfaces with an architectural finish, use stainless steel protected legs (Type B).

4. Over waterproof membranes, use precast concrete chairs.
5. For epoxy-coated reinforcing, use wire reinforcing supports coated with dielectric material including epoxy or another polymer for minimum distance of two inches from point of contact with epoxy-coated reinforcement.

G. Adhesive Dowels:
1. Dowels:
a. Dowel reinforcing bars shall be deformed in accordance with ASTM A615, Grade 60.
2. Adhesive:
a. Requirements for adhesive are specified under requirements for concrete adhesive anchors in Section 05051, Anchor Systems.

2.2 FABRICATION

A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with ACI 301 and ACI 350.5. In case of fabricating errors, do not re-bend or straighten reinforcing in manner that injures or weakens material.

B. Unacceptable Materials: Reinforcing with one or more of the following defects is not allowed:
1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
2. Bends or kinks not shown on approved Shop Drawings.
3. Bars that do not meet or exceed their ASTM specification requirements when hand-wire-brushed, with respect to cross section, nominal weight, or average height of deformations.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which concrete reinforcing is to be placed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with applicable requirements of Laws and Regulations, applicable standards, and ACI 301 and ACI 350.5 for details and methods of reinforcing placement and supports.

B. Clean reinforcing to remove loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Position, support, and secure reinforcing against displacement during formwork construction and concrete placing. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
1. Place reinforcing to obtain minimum concrete coverages specified in the Contract Documents. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcing accurately in position during concrete placing. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
2. Prior to placing concrete, using surveyor's level or string line, demonstrate to Engineer that specified cover of reinforcing has been attained.
3. Do not secure reinforcing steel to forms with wire, nails, or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.

D. Allowable Placing Tolerances: Comply with ACI 301 and ACI 350.5, except as specified in this Section:
   1. Concrete surfaces in contact with liquid shall have minimum of two inches of concrete over reinforcing steel.

E. Provide sufficient number of supports of strength required to carry reinforcing. Do not place reinforcing bars more than two inches beyond last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

F. Lap Splices:
   1. Provide standard reinforcing splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars as shown on the Drawings.

G. Install welded wire fabric in lengths as long as practical. Lap adjoining pieces at least one full mesh and lace splices with 16-gage wire. Do not make end laps midway between supporting beams, or directly over beams of continuous structures. Offset end laps in adjacent widths to prevent continuous laps.

H. Mechanical Couplers:
   1. Mechanical butt splices shall be in accordance with recommendations of mechanical splicing device manufacturer. Butt splices shall develop 125 percent of specified minimum yield tensile strength of spliced bars or of smaller bar in transition splices. Bars shall be flame-dried before butt splicing. Provide adequate jigs and clamps or other devices to support, align, and hold longitudinal centerline of bars being butt spliced in straight line.

I. Welded Splices:
   1. When field welding of reinforcing is required on the Drawings or allowed by Engineer in writing, welding of reinforcing bars shall conform to ANSI/AWS D1.4. Preheating and rate of cooling requirements shall be based on bar steel chemistry and ANSI/AWS D1.4. Welded splices shall be sized and constructed to transfer minimum of 125 percent of specified minimum yield tensile strength of spliced bars or of smaller bar in transition splices. Unless otherwise allowed by ENGINEER in writing, welding of crossing bars (tack welding) for assembly of reinforcement is prohibited.
   2. Welding of wire to wire, and of wire or welded wire fabric to reinforcing bars or structural steels, shall conform to applicable provisions of ANSI/AWS D1.4 and Engineer's requirements for the particular application.
   3. After completing welding on coated reinforcing bars, repair coating damage as specified in this Section. Welds and steel splice members, when used to splice bars, shall be coated with same material used for repair of coating damage.

J. Adhesive Dowels:
   1. Comply with manufacturer's written installation instructions and requirements of this Section.
   2. Drill holes to adhesive system manufacturer's recommended drill bit diameter and to specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances indicated in ANSI B212.15. Core-drilled holes shall not be permitted.
   3. Before setting adhesive dowel, hole shall be made free of dust and debris by method recommended by adhesive system manufacturer. Brush the hole with adhesive system manufacturer-approved brush and blow hole clean with clean, dry, oil-free compressed air to remove dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
   4. Before injecting adhesive, obtain Engineer's concurrence that hole is dry and free of oil and other contaminants.

5. Prior to injecting adhesive into the drilled hole, dispense to an appropriate location for waste an initial amount of adhesive from the mixing nozzle until adhesive is a uniform color, indicating that product is properly mixed.
6. Inject adhesive into hole through injection system-mixing nozzle and extension tubes (as required) placed to bottom of hole. Withdraw nozzle's discharge end as adhesive is placed while keeping nozzle immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during dowel placing.
7. Twist dowel during insertion into partially-filled hole to ensure full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining or adjacent Work that could impose or impart load on the dowels. Do not begin adjoining or adjacent Work until dowels are successfully tested or when approved by Engineer.
9. Limitations:
    a. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with requirements of adhesive systems manufacturer during installation and adhesive system curing.
    b. Oversized Holes: Advise Engineer immediately if size of drilled hole is larger than recommended by adhesive system manufacturer. Cost of corrective measures, including but not limited to redesign of dowels due to decreased capacities, shall be paid by Contractor.

3.3 FIELD QUALITY CONTROL

A. Site Inspections and Tests:
    1. General:
        a. Do not place concrete until reinforcing is inspected, and permission for placing concrete is granted by Engineer. Concrete placed in violation of this provision will be rejected.
        b. Do not close up formwork for walls and other vertical members until reinforcing is inspected, and permission for placing concrete is granted by Engineer. Concrete placed in violation of this provision will be rejected.
        c. Correct defective Work by removing and replacing or correcting, as required by Engineer.
        d. Contractor shall pay cost of corrections and subsequent testing required to confirm integrity of post-installed anchors.
        e. Owner's testing laboratory will submit test results to Contractor and Engineer within 24 hours of completion of test.
    2. Site Tests:
        a. Owner will employ testing laboratory to perform field quality testing of adhesive dowels at the Site.
            1) Testing shall comply with ASTM E488.
            2) Test at least ten percent of each type of adhesive dowel. If one or more dowels fail the test, Contractor shall pay cost to test all dowels of same diameter and type installed on the same day as the failed dowel.
            3) Test dowels to 60 percent of specified yield strength. Engineer will direct which dowels are to be tested.
            4) Apply test loads with hydraulic ram.
            5) Displacement of dowels shall not exceed D/10, where D is nominal diameter of dowel.
    3. Inspection of Welded Splices: Owner will employ testing laboratory to perform field quality control testing of welded splices. All welded splices shall be visually inspected.

Radiographically test minimum of five percent of butt splice welds. Repair defective welds so that welds are completely sound.

B. Manufacturer's Services:
   1. Provide qualified adhesive manufacturer's representative at the Site during initial installation of adhesive dowel systems to train installing personnel in proper selection and installation procedures. Manufacturer's representative shall observe to verify that installer demonstrates proper installation procedures for adhesive dowels and adhesive material. Each installer shall be certified in writing by manufacturer as qualified to install adhesive anchors.

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SECTION 03251

CONCRETE ACCESSORIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete accessories.

B. Related Sections:
   1. Section 03100, Concrete Forming.
   2. Section 03600, Grouting.
   3. Section 07920, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 301, Specifications for Structural Concrete.
   2. ACI 350.5, Specifications for Environmental Concrete Structures.
   3. ASTM D1752, Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
   4. CRD-C572, U.S. Army Corps of Engineers Specifications for Polyvinyl- Chloride Waterstop.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Layout of construction and expansion joint locations. Submit and obtain approval prior to submitting concrete reinforcement Shop Drawings. Concrete reinforcing shop drawings will not be reviewed until construction and expansion joint shop drawings have been approved.
      b. For construction and expansion joints that require waterstops, submit layout of locations showing waterstop details. Indicate waterstop type, waterstop joint conditions, and details on how joint conditions will be handled.
      c. Detail for joining PVC to steel waterstops.
      d. Layout of all control joint locations.
   2. Samples:
      a. Submit Sample, at least six inches long each, of each type of waterstop proposed for use.
      b. Submit Sample of foam rubber and cork expansion joint fillers.
      c. Submit Sample of each type of prefabricated PVC waterstop joint.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions: Manufacturer's specifications and installation instructions for materials required.

1.4 DELIVERY, STORAGE AND HANDLING

A. Transportation and Handling of Products:
   1. Deliver materials to Site to ensure uninterrupted progress of the Work.
   2. Comply with Section 01600, Delivery, Storage and Handling.

B. Storage and Protection:
   1. Store concrete joint materials on platforms or in enclosures or covered to prevent contact with ground and exposure to weather and direct sunlight. Comply with manufacturer's storage and protection requirements.
   2. Comply with Section 01600, Delivery, Storage and Handling.

PART 2 – PRODUCTS

2.1 WATERSTOPS

A. Polyvinyl Chloride (PVC):
   1. Material Requirements:
      a. Waterstops shall be extruded from elastomeric PVC compound containing plasticizers, resins, stabilizers, and other materials necessary to meet requirements of the Contract Documents and requirements of CRD-C572. Do not use reclaimed or scrap material.
      b. Tensile strength of finished waterstop: 1,400 psi, minimum.
      c. Ultimate elongation of finished waterstop: 280 percent, minimum.
      d. Minimum thickness shall be 3/8-inch over entire width of waterstop.
      e. Provide waterstops with minimum of seven ribs equally spaced at each end on each side. First rib shall be at the edge. Ribs shall be a minimum of 1/8-inch in height.
      f. Provide waterstops with hog rings or factory-installed grommets anchored to exterior ribs to facilitate tying waterstop in position.
   2. Split waterstops are not allowed.
   3. Construction Joints: Waterstops shall be flatstrip ribbed type, six-inch minimum width, unless otherwise shown or indicated in the Contract Documents.
   4. Expansion Joints: Waterstops shall be centerbulb ribbed type, nine-inch minimum width, unless otherwise shown or indicated in the Contract Documents. Centerbulb shall have minimum outside diameter of 7/8-inch.
   5. Product and Manufacturer: Provide one of the following:
      a. W.R. Meadows, Inc.
      b. Durajoint Concrete Accessories.
      c. Greenstreak Plastic Products Company.
      d. Paul Murphy Plastics Company.
      e. Vinylex Corporation.
      f. Or equal.

B. Hydrophilic Waterstop Materials:
   1. General Material Properties:
      a. Bentonite-free, and expandable by minimum of 80 percent of dry volume in presence of water to form watertight joint seal without damaging concrete in which material is cast. Provide only where shown or indicated in the Contract Documents.
      b. Material shall be composed of resins and polymers that absorb water and cause an increase in volume in completely reversible and repeatable process. Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
      c. Select materials that are recommended by manufacturer for type of liquid to be contained.
   2. Hydrophilic Rubber Waterstop:
      a. Minimum cross sectional dimensions shall be 3/16-inch by 3/4-inch.
      b. Product and Manufacturer: Provide one of the following:
         1) Duroseal Gasket, by BBZ USA, Inc.
         2) Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.
         3) Hydrotite, by Greenstreak Plastic Products Company.

4) Or equal.

3. Hydrophilic Sealant:
   a. Hydrophilic sealant shall adhere firmly to concrete, metal, and PVC in dry or damp condition. When cured sealant shall be elastic indefinitely.
   b. Product and Manufacturer: Provide one of the following:
      1) Duroseal Paste, by BBZ USA, Inc.
      2) Adeka Ultraseal P-201, by Asahi Denka Kogyo K.K.
      3) Hydrotite, by Greenstreak Plastic Products Company.
      4) SikaSwell S, by Sika Corporation.
      5) Or equal.

C Injection Hose Waterstop System:
1. Injection Hose Waterstop:
   a. Injection hose shall consist of PVC or neoprene central core of sufficient strength to resist weight of minimum of 25 vertical feet of fresh concrete placed upon it. Provide injection openings closely spaced in minimum of three locations equally spaced around perimeter of hose. Seal openings with strips of closed cell foam of consistency to act as one-way valves preventing entrance of cement paste while allowing free flow of injection material, pumped through hose, into the concrete joint surface.
   b. Injection hose system shall be appropriate for injection of hydrophilic injection resin. Hose shall allow for vacuuming operations and repeated use. Construction of hose shall permit free discharge of specified injected grout into concrete without backwash, for entire length of hose.
   c. Injection hose system shall be complete with hold-down clips, connection tubes, fittings, and injection connections designed to be mounted flush with concrete surface and sealed to allow future injections. All system components shall be provided by same manufacturer.
   d. Product and Manufacturer: Provide one of the following:
      1) Fuko Injection System, by BBZ USA, Inc.
      2) SikaSwell Hose, by Sika Corporation.
      3) Or equal.
2. Hydrophilic Injection Resin:
   a. Hydrophilic injection resin shall be acrylate-ester based. Viscosity shall be less than 50 centipoises (cps). Resin shall be water soluble in its uncured state, solvent-free, and non-water reactive. In cured state, resin shall form solid, hydrophilic, flexible material resistant to permanent water pressure, and shall not attack bitumen, joint sealants, and concrete.
   b. Product and Manufacturer: Provide one of the following:
      1) Duroseal Inject 1K/2K, by BBZ USA, Inc.
      2) Sika Injection 29, by Sika Corporation.
      3) Or equal.

2.2 PREFORMED EXPANSION JOINT FILLER

A. Provide preformed expansion joint filler complying with ASTM D1752, Type I (sponge rubber) or Type II (cork).

2.3 CONCRETE CONSTRUCTION JOINT ROUGHENER

A. Provide water-soluble non-flammable, surface-retardant roughener.

B. Product and Manufacturer: Provide one of the following for the types of joints specified:
   1. Rugasol-S, by Sika Corporation for horizontal joints only.

2. Concrete Surface Retarder-Formula S, by Euclid Chemical Company, for horizontal joints only.
3. Concrete Surface Retarder-Formula F, by Euclid Chemical Company, for vertical joints only.
4. TK-6100 Concrete Form Surface Retarder, by TK Products.
5. Or equal.

2.4 EPOXY BONDING AGENT

A. Provide a two-component epoxy-resin bonding agent.

B. Product and Manufacturer: Provide one of the following:
1. Sikadur 32 Hi-Mod LPL, by Sika Corporation.
2. Eucopoxy LPL, by the Euclid Chemical Company.
3. Resi-Bond J-58, by Dayton Superior.
4. Or equal.

2.5 EPOXY-CEMENT BONDING AGENT

A. Provide three component epoxy resin-cement blended formulated as bonding agent.

B. Product and Manufacturer: Provide one of the following:
1. Sika Armatec 110 EpoCem, as manufactured by Sika Corporation.
2. Duralprep A.C., as manufactured by the Euclid Chemical Company.
3. Emaco P24, as manufactured by MBT/ChemRex.
4. Or equal.

2.6 JOINT SEALANT AND ACCESSORIES

A. For joint sealants and accessories used on isolation joints, control joints, and expansion joints, refer to Section 07920, Joint Sealants.

2.7 CONCRETE BOND BREAKERS

A. Provide asphalt-saturated rag felt building paper, not less in weight than commercially known as 15 pound felt building paper, which weighs 15 pounds per 100 square feet.

PART 3 – EXECUTION

3.1 INSPECTION

A. Contractor and installing Subcontractor, if any, shall examine substrate and conditions under which the Work is to be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 CONSTRUCTION JOINTS

A. Comply with requirements of ACI 301, ACI 350.5 and the Contract Documents.

B. Locate and install construction joints as shown or indicated on the Drawings. Where not shown or indicated, locate joints to not impair strength of the structure; position joints at points of minimum shear. Location of joints shall be approved by Engineer. In addition to joints shown or indicated on the Drawings, locate construction joints as follows:
1. In foundation mats, locate joints at a maximum spacing of 50 feet. Joints shall be located within middle third of element span, unless otherwise shown or indicated on the Drawings.

Element span shall be considered distance between piles or, as determined by Engineer, distance between bearing elements, such as columns, exterior walls and interior walls. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.

2. In walls, locate joints at a maximum spacing of 40 feet. Locate joints away from wall intersections a minimum of one-quarter of the clear span distance between wall intersections measured horizontally.
3. In structural slabs and beams, joints shall be located within middle third of element span and shall be located in compliance with ACI 301 and ACI 350.5, unless otherwise shown or indicated on the Drawings.
4. In slabs on grade, locate joints at a maximum spacing of 40 feet. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.

C. Horizontal Joints:
1. Roughen concrete at interface of construction joints by abrasive blasting, hydroblasting, or using surface retardants and water jets to expose aggregate and remove accumulated concrete on projecting rebar immediately subsequent to form stripping, unless otherwise approved by Engineer. Do not allow surface retardants to contact waterstop. Protect waterstop from blasting. Immediately before placing fresh concrete, thoroughly clean existing contact surface using stiff brush or other tools and stream of pressurized water. Surface shall be clean and wet, and free from pools of water at time of placing fresh concrete.
2. Remove laitance, waste mortar, and other substances that may prevent complete adhesion. Where joint roughening was performed more than seven days prior to concrete placing or where dirt or other bond reducing contaminants are on surface, perform additional light abrasive blasting or hydroblasting to remove laitance and bond-reducing materials just prior to concrete placement.
3. Provide over contact surface of concrete a six-inch layer of Construction Joint Grout as specified in Section 03600, Grouting. Place fresh concrete before grout has attained its initial set. Placement of grout may be omitted if concrete mix has slump increased to at least six inches by addition of high range water reducer.

D. Vertical Joints:
1. Apply roughener to the form in thin, even film by brush, spray, or roller in accordance with manufacturer's instructions. Do not allow roughener onto waterstop. Clean off any roughener that contacts the waterstop. After roughener is dry, concrete may be placed.
2. When concrete has been placed, remove joint surface forms as early as necessary to allow for removal of surface retarded concrete. Forms covering member surfaces shall remain in place as required under Section 03100, Concrete Forming. Wash loosened material off with high-pressure water spray to obtain roughened surface subject to approval by Engineer. Alternately, surface shall be roughened by abrasive blasting or hydroblasting to expose aggregate. Outer one-inch of each side of joint face shall be masked and protected from blasting to avoid damaging member surface. Protect waterstop from blasting.

3.3 EXPANSION JOINTS

A. Comply with requirements of ACI 301, ACI 350.5, and this Section.

B. Locate and install expansion joints as shown and indicated in the Contract Documents. Install joint filler in accordance with manufacturer's instructions. Install sealants as specified in this Section.

3.4 CONTROL JOINTS

A. Provide control joints in non-water bearing slabs on grade as shown or indicated on the Drawings. Where control joints are not shown or indicated on the Drawings, space control joints at 24 to 36

times thickness of slab in both directions. Locate control joints only at places approved by Engineer.

B. A groove, with depth of at least 25 percent of the member thickness, shall be tooled, formed, or saw-cut in concrete. Groove shall be filled with joint sealant material in accordance with Section 07920, Joint Sealants.

C. Where control joint is formed by sawcutting, make sawcut in presence of Engineer immediately after concrete has set sufficiently to support the saw and be cut without damage to concrete. Keep concrete continually moist during cutting. Joints shall be 1/8-inch (+/- 1/32-inch) wide.

D. Control joints may be formed with tool or by inserting joint forming strip. After concrete has achieved design strength, remove upper portion of joint forming strip and fill void with sealant.

3.5 ISOLATION JOINTS

A. Provide isolation joint where sidewalk or other slab on grade abuts a concrete structure and slab on grade is not shown doweled into that structure. Form isolation joint by 1/2-inch joint filler with upper 1/2-inch of joint filled with sealant.

3.6 WATERSTOPS

A. General:
   1. Comply with ACI 301, ACI 350.5, and this Section. Make joints in accordance with manufacturer's instructions.
   2. Provide PVC waterstops, except where otherwise shown or indicated on the Drawings.
   3. Provide waterstops in all joints where concrete construction is below grade or intended to retain liquid. Install waterstop to the higher of: at least 12 inches above grade, or 12 inches above overflow liquid level in tanks.
   4. Waterstops shall be fully continuous for extent of joint and with waterstops in intersecting joints. Maintain waterstop continuity at transitions between waterstops in joints at different levels and orientations.
   5. In vertical joints in walls that are free at the top, waterstops shall extend no closer than six inches from top of wall.
   6. In placing concrete around horizontal waterstops, with waterstop flat face in horizontal plane, work the concrete under waterstops by hand to avoid forming air and rock pockets.

B. Polyvinyl Chloride Waterstop:
   1. Waterstops shall be positively held from displacement during concrete placing. Tie waterstops to reinforcement or other rigid supports at maximum spacing of 18 inches so that waterstop is securely and rigidly supported in proper position during concrete placing. Continuously inspect waterstops during concrete placing to ensure proper positioning.
   2. Perform splicing in waterstops by heat sealing adjacent waterstop sections in accordance with manufacturer's printed recommendations. The following is required:
      a. Material shall not be damaged by heat sealing.
      b. Splices shall have tensile strength of not less than 60 percent of unspliced material's tensile strength.
      c. Maintain the continuity of waterstop ribs and of its tubular center axis.
   3. Only butt-type joints of ends of two identical waterstop sections shall be made while material is in forms.
   4. Prefabricated PVC Waterstop Joint:
      a. Joints with waterstops involving more than two ends to be jointed together, and joints that involve an angle cut, alignment change, or joining of two dissimilar waterstop sections, shall be prefabricated by Contractor or manufacturer prior to placing in the forms.

b. Prefabricated joints shall have minimum of 2.0 feet of waterstop material beyond joint in each direction.
c. Install prefabricated joint assembly in the forms and butt-weld each two-foot end to a straight-run portion of waterstop in place in the forms.

5. Where centerbulb waterstop intersects and is jointed with non-centerbulb waterstop, seal end of centerbulb using additional PVC material as required.
6. Symmetrical halves of waterstops shall be equally divided between concrete placements at joints and centered within joint width, unless shown or indicated otherwise in the Contract Documents. Place centerbulb waterstops in expansion joints so that centerbulb is centered on joint filler material.
7. When waterstop is installed in the forms or embedded in first concrete placement and waterstop remains exposed to atmosphere for more than four days, implement suitable precautions to shade and protect exposed waterstop from direct rays of sun during entire exposure, until exposed portion of waterstop is embedded in concrete.
8. Protect waterstop placed in joints intended for future concrete placement from direct rays of the sun by temporary means until permanent cover is installed, so that waterstop is not exposed to direct rays of the sun for more than four days total.

C. Hydrophilic Rubber Waterstop and Sealant:
1. Where a hydrophilic rubber waterstop or sealant is required in accordance with the Contract Documents, or where approved by Engineer, install waterstop or sealant in accordance with manufacturer's instructions and recommendations; except, as modified in the Contract Documents.
2. When requested by Engineer, provide manufacturer's technical assistance at the Site.
3. Locate waterstop or sealant as near as possible to center of joint. Waterstop or sealant shall be continuous around entire joint. Minimum distance from edge of waterstop to face of the member shall be three inches.
4. Where hydrophilic rubber waterstop is used in combination with PVC waterstop, hydrophilic rubber waterstop shall overlap PVC waterstop for minimum of six inches. Fill contact surface between hydrophilic rubber waterstop and PVC waterstop with hydrophilic sealant.
5. Where wet curing methods are used, apply hydrophilic rubber waterstop and sealant after curing water is removed and just prior to closing up of the forms for concrete placement. Protect hydrophilic rubber waterstop and sealant from direct rays of sun and from becoming wet prior to concrete placement. If material becomes wet and expands, allow material to dry until material has returned to original cross sectional dimensions before placing concrete.
6. Install hydrophilic rubber waterstop in bed of hydrophilic sealant, before skinning and curing begins, so that irregularities in concrete surface are completely filled and waterstop is bonded to sealant. After sealant has cured, install concrete nails, with washers of a diameter equal to waterstop width, to secure waterstop to concrete at maximum spacing of 1.5 feet.
7. Prior to installing hydrophilic sealant, wire brush or sandblast the concrete surface to remove laitance and other materials that may interfere with bonding. Metal and PVC surfaces to receive sealant shall be cleaned of paint and materials that may interfere with bond. When sealant alone is shown or indicated in the Contract Documents, place sealant placed in built-up bead which has a triangular cross section with each side of triangle at least 3/4-inch long, unless otherwise indicated in the Contract Documents. Do not place concrete until sealant has cured as recommended by sealant manufacturer.

D. Injection Hose Waterstop:
1. Provide injection hose waterstop where shown or indicated on the Drawings.
2. Install injection hose in maximum lengths recommended by manufacturer, but not greater than 40 feet.

3. Clean concrete surface of debris prior to installing injection hose. Install injection hose on two-inch wide strip of unroughened concrete at center of member width in direct contact with concrete. Clamp hose into position with anchor clips set into concrete spaced no more than 10 inches on centers.
4. Where injection hose is used in combination with PVC waterstop, hose shall overlap PVC waterstop for minimum of six inches and shall be less than two inches away from PVC waterstop.
5. Provide each end of injection hose with solid injector hoses mounted to formwork using a fitting. Provide fitting with cover that seals hose from cement paste and serves as a removable and reinstallable cover for future reinjections. Mount fittings on dry side of member, unless shown otherwise on the Drawings.
6. Hose system shall not be injected until authorization is given by Engineer. When authorized, hose system shall be injected with hydrophilic resin in conformance with manufacturer's recommendations. Injection shall be by an applicator authorized by injection system manufacturer.
7. Injection system Supplier shall provide necessary supervision to satisfy Engineer that application conforms strictly to manufacturer's recommendations.
8. Prior to resin injection, flush hose system with water. At end of injection operation, clean the hose system in accordance with manufacturer's recommendations to facilitate future injections. Plug and cover injection and vent ends of system, leaving system ready for future reinjections.

3.7 BONDING AGENT

A. Use epoxy bonding agent for bonding of fresh concrete to concrete that has been in place for at least 60 days, and for bonding to existing concrete.

B. Use epoxy-cement bonding agent for the following:
   1. Bonding toppings and concrete fill to concrete that has been in place for at least 60 days, and for bonding to existing concrete.
   2. For locations where bonding agent is required and concrete cannot be placed within open time period of epoxy bonding agent.
   3. Bonding of horizontal construction joints where joints are required in accordance with the Drawings or approved by Engineer for foundation mats that are five feet thick or greater.

C. Use cement-water slurry as bonding agent for toppings and concrete fill to concrete that has been in place for less than 60 days. Cement water slurry shall be worked into surface with stiff bristle broom and place the concrete before cement-water slurry dries.

D. Handle and store bonding agent in accordance with manufacturer's printed instructions and safety precautions.

E. Mix bonding agent in accordance with manufacturer's instructions.

F. Before placing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with bonding agent not less than 1/16-inch thick. Place fresh concrete while bonding agent is still tacky (within its open time), without removing in-place bonding agent coat, and as directed by manufacturer.

+ + END OF SECTION + +

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install cast-in-place concrete.
   2. Concrete shall be in accordance with requirements of ACI 301 and ACI 350.5 unless otherwise specified.
   3. The Work includes providing concrete consisting of portland cement, fine and coarse aggregate, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured. The Work also includes:
      a. Providing openings in concrete to accommodate the Work under this and other Sections and building into the concrete all items such as sleeves, frames, anchorage devices, inserts, and all other items to be embedded in concrete Work.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items to be installed in the concrete Work.

C. Classifications of Concrete:
   1. Class “A” concrete includes the following:
      a. All concrete, unless otherwise shown or indicated.
   2. Class “AF” concrete may be used in lieu of Class “A” concrete for the following:
      a. Walls and foundations thicker than 16 inches.
   3. Class “AS” concrete shall be provided, where shown or indicated, for slabs not exposed to freezing and thawing where troweled finish is required.
   4. Class “B” concrete shall be placed without forms or with simple forms, with little or no reinforcing, and includes the following, unless otherwise shown or indicated:
      a. Concrete fill within structures.
      b. Duct banks.
      c. Unreinforced encasements.
      d. Curbs and gutters.
      e. Sidewalks.
      f. Thrust blocks.
   5. Class “C” concrete shall be provided where shown or indicated for slabs that require enhanced durability against wear.
   6. Class “D” concrete shall be unreinforced and used where required as concrete fill under foundations, filling abandoned piping, and where “lean concrete” or “mudmat” is shown or indicated in the Contract Documents.

D. Related Sections:
   1. Section 03251, Concrete Accessories.
   2. Section 03600, Grouting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AASHTO M182, Specification for Burlap Cloth Made From Jute or Kenaf and Cotton Materials.
   2. AASHTO TP23, Test Method for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.

3. ACI 117, Specifications for Tolerances for Concrete Construction and Materials and Commentary.
4. ACI 301, Specifications for Structural Concrete.
5. ACI 305.1, Specification for Hot Weather Concreting.
6. ACI 306.1, Standard Specification for Cold Weather Concreting.
7. ACI 308.1, Specification for Curing Concrete.
8. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
9. ACI 350/350R, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
10. ACI 350.5, Specifications for Environmental Concrete Structures.
11. ASTM C31/C31M, Practice for Making and Curing Concrete Test Specimens in the Field.
12. ASTM C33, Specification for Concrete Aggregates.
13. ASTM C39/C39M, Test Method for Compressive Strength of Cylindrical Con-crete Specimens.
14. ASTM C42/C42M, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
15. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
16. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
17. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
18. ASTM C143/C143M, Test Method for Slump of Hydraulic- Cement Concrete.
19. ASTM C150, Specification for Portland Cement.
20. ASTM C157/C157M, Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
21. ASTM C171, Specification for Sheet Materials for Curing Concrete.
22. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
23. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
24. ASTM C260, Specification for Air-Entraining Admixtures for Concrete.
25. ASTM C309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
26. ASTM C494/C494M, Specification for Chemical Admixtures for Concrete.
27. ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
28. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
29. ASTM C989, Specification for Slag Cement for Use in Concrete and Mortars.
30. ASTM C1017, Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
31. ASTM C1064/C1064M, Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
32. ASTM C1077, Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
33. ASTM C1240, Specification for Silica Fume Used in Cementitious Mixtures.
34. ASTM C1260, Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
35. ASTM C1293, Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
36. ASTM C1567, Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
37. ASTM D1042, Test Method for Linear Dimensional Changes of Plastics Caused by Exposure to Heat and Moisture.
38. ASTM D3574, Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams.
39. ASTM E96/E96M, Test Methods for Water Vapor Transmission of Materials

40. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
41. ASTM E1643, Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
42. ASTM E1745, Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
43. NRMCA, National Ready Mixed Concrete Association.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Concrete Testing Laboratory:
      a. Employ independent testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes.
         1) Testing agency shall be in accordance with ASTM E329 and ASTM C1077.
         2) Testing laboratory shall have been inspected and passed within previous two years by Cement and Concrete Reference Laboratory (CCRL) of NIST for: testing concrete aggregates, and for preparing and testing concrete trial batches with or without admixtures. Testing laboratory shall provide documentation indicating how deficiencies, if any, in most recent CCRL inspection report were corrected.
         3) Selection of testing laboratory is subject to Owner's acceptance.
         4) Submit written description of proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities, and equipment, and other information requested by Engineer.
   2. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
   3. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor's Licensed Design Engineer.
   4. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher, or equivalent.
   5. Water Reducing Admixture Manufacturer:
      a. Water-reducing admixtures shall be manufactured under strict quality control in facilities operated under a quality assurance program. Submit copy of manufacturer's quality assurance handbook to document program existence.
      b. Manufacturer shall maintain a concrete testing laboratory approved by CCRL at NIST.
      c. Manufacturer shall be capable of providing services of qualified field service representatives at the Site.

B. Laboratory Trial Batch:
   1. Each concrete mix design specified shall be verified by laboratory trial batch, unless indicated otherwise.
   2. For classes of concrete that require air-entrainment, test the trial batch at highest percentage of air allowed for that class of concrete.
   3. Perform the following testing on each trial batch:
      a. Aggregate gradation for fine and coarse aggregates.
      b. Fly ash testing to verify meeting specified properties, unless fly ash Supplier submits certification by an independent testing laboratory.
      c. Slump.
      d. Air content.
      e. Compressive strength based on three cylinders each tested at seven days and at 28 days.

f. Shrinkage test in accordance with this Section, for Class "A" concrete and Class "AF" concrete.

4. Submit for each trial batch the following information:
   a. Project identification name and number (if applicable).
   b. Date of test report.
   c. Complete identification of aggregate source of supply.
   d. Tests of aggregates for compliance with the Contract Documents.
   e. Scale weight of each aggregate.
   f. Absorbed water in each aggregate.
   g. Brand, type, and composition of cementitious materials.
   h. Brand, type, and amount of each admixture.
   i. Amounts of water used in trial mixes.
   j. Proportions of each material per cubic yard.
   k. Gross weight and yield per cubic yard of trial mixtures.
   l. Measured slump.
   m. Measured air content.
   n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28 day test, and for each design mix.
   o. Shrinkage test results where required and as specified in this Section. Report results and averages for original length and at zero, seven, 14, 21, and 28 days of drying.

C. Shrinkage Test:
   1. Perform drying shrinkage tests for trial batch as specified in this Section.
   2. Drying shrinkage specimens shall be four-inch by four-inch by 11-inch prisms with effective gage length of ten inches; fabricated, cured, dried, and measured in accordance with ASTM C157 modified as follows: remove specimens from molds at an age of 23 hours, plus-or-minus one hour, after trial batching; shall be placed immediately in water at 70 degrees F plus-or-minus three degrees F for at least 30 minutes; and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F plus-or-minus three degrees F. Measurement to determine expansion expressed as percentage of original length shall be made at age of seven days. Length at age of seven days shall be base length for drying shrinkage calculations (zero days drying age). Immediately afterward store specimens in humidity-controlled room maintained at 73 degrees F plus-or-minus three degrees F, and 50 percent (plus-or-minus four percent) relative humidity for remainder of test. Obtain measurements to determine shrinkage expressed as percentage of base length and report measurements separately for seven, 14, 21, and 28 days of drying after seven days of moist curing.
   3. Determine drying shrinkage deformation of each specimen as the difference between base length (at zero days drying age) and length after drying at each test age. Determine average drying shrinkage deformation of specimens to nearest 0.0001-inch at each test age. If drying shrinkage of a specimen departs from average of that test age by more than 0.0004-inch, results obtained from that specimen shall be disregarded. Report results of shrinkage test to nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from same concrete used for preparing drying shrinkage specimens. Tests shall be considered part of normal compression tests for the Work. Allowable shrinkage limitations shall be as specified in Part 2 of this Section.

D. Component Supply and Compatibility:
   1. Provide a certificate of compatibility for all admixture materials.

E. Sample Panels:
   1. Provide Sample panels of wall finishes, each at least 12 inches by 12 inches by three inches thick. Revise Sample panels to produce acceptable finished concrete surfaces.
      a. Provide additional Sample panels as required if original results are unsatisfactory as determined by Engineer.

2. Continuity of color and texture for exposed concrete surfaces is important. Maintain such controls and procedures, in addition to those specified, as necessary to provide continuous match of concrete Work with approved Samples.

F. Mock-up Panels:
   1. Provide mock-up panels representative of specified finished surfaces after sample form panels are approved, at locations on the Site directed by Engineer. Form, reinforce, mix, cast, cure, and finish mock-up panels using selected materials and construction methods proposed for the Work. Provide mock-up panels as follows:
      a. Wall section of L-shaped panels, approximately four feet high by three feet each side by eight inches thick and set on an 18-inch wide by eight-inch thick base, unless otherwise shown or indicated. Form faces to represent each specified formed surface finish. Include not less than two form ties, two form panel intersections, one vertical construction joint, and one horizontal construction joint. Construction joints are in Section 03251, Concrete Accessories.
      b. Column section, approximately four feet high and not less than 12-inch diameter for round sections, and not less than 12 inches in the least dimension for rectangular sections, for each specified formed finish, unless otherwise shown or indicated. Set column sections on a six-inch thick concrete base extending eight inches beyond column. Chamfer exposed edges of rectangular Sample columns.
      c. Slab-on-grade section, approximately four feet square and minimum of four inches thick for each applied finish, with at least one construction joint and one expansion joint, if used.
   2. Reinforce mock-up panels as required to prevent cracking and to be structurally stable or as shown or indicated; reinforcing steel shall not be less than 0.25 percent of the gross concrete cross section in each direction.
   3. Protect mock-up panels from damage and do not remove approved mock-up panels without written Engineer's permission. When directed by Engineer, demolish mock-up panels and remove from the Site.

G. Existing Example Panels:
   1. Engineer will identify sections of existing concrete that will serve as reference examples of acceptable concrete finishes.
   2. If appropriate existing concrete members that adequately define required finishes do not exist, provide Sample panels as specified in this Article.

H. Designated Finish Sample Areas:
   1. Engineer will identify areas of concrete members, to serve as reference examples of acceptable concrete finishes, from first members constructed for each finish.
   2. At each area so designated, complete the finish as specified.
   3. Where specified concrete finish is not obtained, repair the member to provide an acceptable finish. Adjust construction techniques to produce the required finish.
   4. Clearly mark each Sample area with name of specified finish to cause no damage to finish.
   5. Protect Sample areas from damage and maintain access to view Sample areas.

I. Thermal Control Plan
   1. A thermal control plan shall be developed for all concrete placements in excess of 30 inches in thickness.
   2. Prior to start of concrete placement, test concrete placements a minimum of 6 feet by 6 feet by the each thickness exceeding 30 inches shall be prepared. The test placements shall have thermisters or thermocouples embedded at the mid-point and within 2 inches of the exposed surface. Temperature readings shall be taken at no less than 30 minute intervals until the peak internal temperature is reached. A time-temperature plot of the internal, surface and ambient air temperature shall be prepared. The temperature of the concrete as it is being placed in the test placement shall be recorded. The temperature rise from placement temperature to maximum internal temperature shall be determined.

3. If internal peak temperature exceeds 155 degrees F, one or more of the following actions shall be taken:
    a. Concrete placement temperature shall be reduced by cooling mix ingredients so that the peak temperature does not reach 155 degrees F.
    b. The concrete mix design shall be adjusted to use supplemental cementitious materials in quantities that will reduce heat of hydration.
    c. A lower heat of hydration Portland cement shall be used.
    d. Means to provide internal cooling of the concrete shall be designed and submitted for approval.
4. The thermal control plan shall provide how the thermal gradient from the interior to exterior of the concrete shall be kept within the following limits: 35 degrees F for the first five days after placing, 45 degrees F during six to ten days after placing, and 60 degrees F after 10 days after placing.

J. Concrete Coordination Conference:
1. Conduct concrete coordination conference to review detailed requirements of Contractor's proposed concrete design mixes, to discuss procedures for producing proper concrete construction, and to clarify roles of the parties involved. Contractor shall organize and schedule the conference, and prepare and distribute to all parties attending conference minutes of the conference.
2. Conduct concrete coordination conference no later than 14 days after the date the Contract Times commence running. Conference shall be held at mutually agreed upon date and time; conference shall be held at the Site unless otherwise mutually agreed upon. Notify all parties to attend concrete coordination conference not less than five days prior to scheduled date of conference.
3. Additional structure specific concrete construction conferences shall be held as required by the Engineer.
4. All parties involved in the concrete Work shall attend concrete coordination conference including, but not limited to, the following:
    a. Contractor.
    b. Field testing services representative.
    c. Concrete Subcontractor (if any).
    d. Reinforcing steel Subcontractor (if any) and reinforcing steel Supplier and detailer.
    e. Concrete Supplier.
    f. Admixture manufacturer's representative.
    g. Engineer.
    h. Resident Project Representative (if any).

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Mix Design:
    a. List of concrete materials and proportions for the proposed concrete mix designs. Include data sheets, test results, certifications, and mill reports to qualify the materials proposed for use in the mix designs. Do not start laboratory trial batch testing until this submittal is approved by Engineer.
    b. Laboratory Trial Batch Reports: Submit laboratory test reports for concrete cylinders, materials, and mix design tests.
    c. Test results per ASTM C33 confirming meets limit on deleterious material in fine aggregate.
    d. Test results per ASTM C1260, ASTM C1293, and ASTM C1567 to determine potential for alkali-silica reactivity.
    e. Certificate of compatibility of combined admixtures.
    f. Certification of mix designer.
2. Concrete Supply:
    a. Ready-mixed Concrete: Submit the following information.

1) NRMCA plant certification.
2) Physical capacity of mixing plant.
3) Trucking facilities available.
4) Estimated average amount of the specified concrete that can be produced and delivered to the Site during a normal, eight-hour day, excluding output to other customers.

3. Product Data:
   a. Manufacturers' specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
4. Samples:
   a. Submit Samples of materials as specified and as requested by Engineer. Include with each Sample names of product and Supplier, and description.
5. Thermal Control Plan:
   a. Submit plan for controlling internal temperature and temperature gradients within specified limits.
6. Curing and Protection Plans:
   a. Submit detailed plan for curing and protection of concrete placed and cured in cold weather.
   b. Submit detailed plan for curing and protection of concrete placed and cured in ambient temperatures over 80 degrees F.

B. Informational Submittals: Submit the following:
1. Certifications:
   a. Notarized certification of conformance to reference standards used in this Section, when required by Engineer.
   b. Flatwork finisher certification.
2. Delivery Tickets: Copies of all delivery tickets for each load of concrete delivered to or mixed at the Site submitted prior to unloading. Each delivery tickets shall contain the information in accordance with ASTM C94 requirements of sections 14.2.1 through 14.2.10 along with project identification name and number (if any), date, mix type, mix time, quantity and amount of water initially withheld and introduced on site.
3. Minutes of the Concrete Coordination Conference and other subsequent structure specific concrete construction conferences.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Transportation, Delivery, and Handling:
1. Materials used for concrete shall be clean and free from foreign matter during transportation and handling, and kept separate until measured and placed into concrete mixer.
2. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.

B. Storage:
1. For storage, provide bins or platforms with hard, clean surfaces.

PART 2 – PRODUCTS

2.1 GENERAL

A. Not used.

2.2 CEMENTITIOUS MATERIALS

A. Cement:

1. Portland cement shall be Type II(MH) ASTM C150. Type I or Type II may be used in lieu of Type II (MH) when approved by Engineer.
2. Portland cement shall be produced by one manufacturer. Alternate cement sources may be used provided that mix design has been approved and acceptable trial batch verifying performance has been made.
3. Do not use cement that has deteriorated because of improper storage or handling.

B. Fly Ash:
1. Fly ash, when used, shall conform to the requirements of ASTM C618 Class F, except as follows:
   a. The loss on ignition shall be a maximum of four percent.
   b. The maximum percent of sulfur trioxide (SO3) shall be 4.0.
2. Fly ash shall be considered to be a cementitious material.
3. Laboratory trial batches shall be tested to determine compliance with strength requirements, times of setting, slump, slump loss, and shrinkage characteristics.

C. Slag Cement:
1. Slag Cement, when used, shall conform to ASTM C989, Grade 120.
2. Slag cement is considered a cementitious material.
3. Perform laboratory tests on trial batches to determine compliance with strength requirements, times of setting, slump, slump loss, and shrinkage characteristics.

D. Silica Fume:
1. Silica fume shall be dry compacted or slurry form and shall conform to ASTM C1240. Silica fume is considered a cementitious material. Application rate, when specified, shall be seven percent by weight of cement, unless indicated otherwise.

E. For all classes of concrete, when Type II (MH) Cement is used, fly ash or slag cement may be used within the following percentages by weight. When Type II Cement is used, fly ash or slag cement shall be used within the following percentages by weight. When Type I Cement is used, in lieu of Type II (MH) Cement, fly ash or slag cement shall be used such that total tricalcium aluminate content (C3A) of the resulting cementitious material is not greater than eight percent.
1. When fly ash is used, material shall have minimum of 20 percent and maximum of 25 percent of total weight of cementitious material.
2. When slag cement is used, material shall have minimum of 40 percent and maximum of 50 percent of total weight of cementitious material.

2.3 AGGREGATES

A. General:
1. Aggregates shall conform to ASTM C33, Class Designation 4S, and as specified in this Section.
2. Do not use aggregates containing soluble salts or other substances, such as iron sulfides, pyrite, marcasite, ochre, or other materials, that can cause stains on exposed concrete surfaces.
3. Aggregates shall be tested to determine potential for alkali-silica reactivity.

B. Fine Aggregate:
1. Provide clean, sharp, natural sand free of loam, clay, lumps, and other deleterious substances.
2. Dune sand, bank run sand, and manufactured sand are unacceptable.

C. Coarse Aggregate:
1. Provide clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:

a. Crushed stone, processed from natural rock or stone.
b. Washed gravel, either natural or crushed. Slag, pit gravel, and bank run gravel are unacceptable.

2.4 WATER

A. Water used in producing and curing concrete shall be clean and free of injurious quantities of oils, acids, alkalis, organic materials, and other substances that may be deleterious to concrete and steel.

2.5 CONCRETE ADMIXTURES

A. Provide admixtures in accordance with product manufacturer's published instructions. Admixtures shall be compatible with each other. Admixtures shall not contain thiocyanates, shall not contain more than 0.05 percent chloride ion, and shall be non-toxic in the concrete mix after 30 days. Do not use admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise approved by Engineer.

B. Air Entraining Admixtures: ASTM C260.
1. Air entraining admixture shall be vinsol resin or vinsol rosin-based.

C. Water-Reducing Admixture: ASTM C494, Type A or D.
1. Proportion Class "A", Class "AF", Class "AS", and Class "B" concrete with non-air entraining, water-reducing, aqueous solution of modified organic polymer.

D. High Range Water-Reducing Admixture (HRWR): ASTM C494, Type F or G.
1. Use high range water-reducing admixture in the concrete classifications so specified or indicated. Use of HRWR admixture is allowed at Contractor's option in all other classifications of concrete. Specific admixture formulation shall be as recommended by admixture manufacturer for Project conditions.

E. Plasticizing Admixtures: ASTM C1017, Type I or Type II
1. Use plasticizing admixture as an alternate to high range water-reducing admixture. Specific admixture formulation shall be as recommended by admixture manufacturer for Project conditions.

F. Set Control Admixtures: In accordance with ASTM C494. Use the following as required:
1. Type B, Retarding.
2. Type C, Accelerating.
3. Type D, Water reducing and Retarding.
4. Type E, Water reducing and Accelerating.
5. Type G, Water-reducing, high range, and retarding admixtures.

G. Calcium Chloride: Do not use calcium chloride.

H. Shrinkage Reducing Admixture:
1. Shrinkage reducing admixture may be used in mix design when necessary to conform to specified shrinkage limitations, provided that specified strength requirements are complied with and there is no reduction in sulfate resistance in the concrete and no increase in concrete permeability.

I. Corrosion-Inhibiting Admixtures:
1. Corrosion-inhibiting admixture shall be calcium nitrite solution containing minimum of 30 percent calcium nitrite. Admixture shall be added at dosage rate of five gallons per cubic yard of concrete.
2. Product and Manufacturer: Provide one of the following:
a. DCI or DCI-S, by Grace Construction Products.

b. Rheocrete CNI, by Master Builders, Inc.
c. Eucon CIA, by Euclid Chemical Company.
d. Or equal.

3. Adjust quantity of mix water to account for water portion of calcium nitrite solution.
4. Provide retarding admixtures as required, if set time is accelerated.

2.6 PROPORTIONING AND DESIGN OF MIXES

A. Prepare concrete design mixes in accordance with Table 03300-A:

TABLE 03300-A
CONCRETE DESIGN MIX CRITERIA

Concrete Class	Coarse Aggregate[1]		Minimum Cementitious[5] (lbs/cu yd)	Max. W/CM[4]	Slump[2]	Air[6] (%)	Min. Comp Strength[3] (psi)
	Size A	Size B					
Class "A"	No. 57	No. 8	535	0.42	4" max.	6 +/- 1.5	4,500
Class "AF"	No. 467	No. 8	517	0.42	4" max.	5 +/- 1.5	4,500
Class "AS"	No. 57	No. 8	535	0.42	4" max.	-	4,500
Class "B"	No. 57 or No. 67		517	0.50	4" max.	6 +/- 1.5	3,000
Class "C"	N. 57 or No. 67		564	0.40	4" max.	3 Max.	5,000
Class "D"	Any ASTM C33		⟵ No requirements ⟶				2,000

Notes Applicable to Table 03300-A:

1. Coarse aggregate size numbers refer to ASTM C33. Where Size A and B are designated in Table 03300-A, it is intended that the smaller Size B aggregate is to be added, replacing a portion of the coarse or fine aggregate, in the minimum amount necessary to make a workable and pumpable mix with sand content not exceeding 41 percent of total aggregate.
2. Slumps indicated are prior to addition of high range water reducing admixture or plasticizing admixture.
3. Mix designs shall be made for all but Class "D", which does not require trial batch, so that the compressive strength achieved for laboratory trial batches will not be less than 125 percent of specified design strength.
4. Quantity of water to be used in the determination of water-cementitious materials (W/CM) ratio shall include free water on aggregates in excess of SSD and water portion of admixtures.
5. Minimum cementitious content shall be adjusted in accordance with the requirements of Table 5.2.2.1 of ACI 350.5 and Table 4.2.2.1 of ACI 301 if smaller maximum coarse aggregate size is used.
6. Required air content listed shall be adjusted in accordance with the requirements of Table 5.2.2.4 of ACI 350.5 and Table 4.2.2.7.b.1 of ACI 301 for severe exposure if a different maximum coarse aggregate size is used.

B. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, Site conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as approved by Engineer. Before using adjusted concrete mixes, laboratory test data and strength results shall be submitted to and approved by Engineer.

C. Admixtures:
   1. Use air-entraining admixture in concrete, unless otherwise shown or indicated. Add air-entraining admixture at admixture manufacturer's prescribed rate to produce concrete at point of placement having air content within prescribed limits.
   2. Use water-reducing or high-range water-reducing admixtures in all Class "A" and Class "AF" concrete.
   3. Use amounts of admixtures recommended by admixture manufacturer for climatic conditions prevailing at the Site at time of placing. Adjust quantities and types of admixtures as required to maintain quality.

D. Slump Limits with High-Range Water Reducer:
   1. Slump shall not exceed four inches prior to adding high-range water reducer and shall not exceed eight inches, measured at point of placement, after adding high-range water reducer.

E. Shrinkage Limitation:
   1. Concrete shrinkage for specimens cast in laboratory from trial batch with total water of 30.2 gallons per cubic yard or less, as measured at 21-day drying age and at 28-day drying age shall not exceed 0.039 percent and 0.045 percent, respectively. For trial batch with total water of 32.7 gallons per cubic yard or greater respective limits shall not exceed 0.035 percent and 0.040 percent. Limits in between shall be linear interpolated. Use mix design for construction that complies with trial batch shrinkage requirements. Shrinkage limitations apply to Class "A" concrete and Class "AF" concrete.
   2. Trial Batch Does Not Comply with Shrinkage Limitation:
      a. If trial batch results do not comply with shrinkage limitation specified in the Contract Documents, redesign the mix to reduce shrinkage.
      b. After mix has been repeatedly redesigned and Engineer is satisfied that all reasonable means to provide concrete mix that complies with shrinkage requirement have been exercised; and mix design still fails to comply with shrinkage limitation in the Contract Documents, Engineer reserves the right to accept the higher-shrinkage mix, provided that the quantity of shrinkage reinforcing in structures is increased.
      c. "Reasonable means" will be construed as reducing the total water content to a maximum of 27 gallons per cubic yard, having the large aggregate blended so that eight percent to 18 percent of combined aggregate is retained on each sieve, using an alternate aggregate source, and a combination of these means.
      d. Basis for shrinkage reinforcing increase will be proportional to amount that shrinkage value is over the specified shrinkage limitation and will be determined by Engineer. The cost of providing additional shrinkage reinforcement will be paid by the Owner.

2.7 BONDING AGENT

A. Provide epoxy and epoxy-cement bonding agents in accordance with Section 03251, Concrete Accessories.

2.8 CONCRETE CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.

B. Curing Mats: Shall be heavy carpets or cotton mats, quilted at four inches on centers, and weighing minimum of 12 ounces per square yard when dry.

C. Moisture-Retaining Cover: Provide one of the following, complying with ASTM C171:
   1. Waterproof paper.
   2. Polyethylene film.
   3. White burlap polyethylene sheet.

D. Liquid Curing Compound: ASTM C309 Type 1-D (water retention requirements):
   1. Provide fugitive dye.
   2. Curing compound shall be applied by roller or power sprayer.

2.9 FINISHING AIDS

A. Evaporation Retardant:
   1. Product and Manufacturer: Provide one of the following:
      a. Confilm, by Master Builders.
      b. Eucobar, by Euclid Chemical Company.
      c. SikaFilm, by Sika Corporation.
      d. Or equal.

2.10 CRACK INJECTION MATERIALS

A. Structural Crack Repair System:
   1. Epoxy for Injection: Low-viscosity, high-modulus moisture insensitive type.
   2. Products and Manufacturers: Provide one of the following:
      a. Sikadur 35, Hi-Mod L.V. and Sikadur 31, Hi-Mod Gel, by Sika Corporation.
      b. Eucopoxy Injection Resin, by Euclid Chemical Company.
      c. Or equal.

B. Non-structural Crack Repair System:
   1. Hydrophobic Polyurethane Chemical Grout:
      a. Provide hydrophobic polyurethane that forms a flexible gasket.
      b. Products and Manufacturers: Provide one of the following:
         1) SikaFix HH LV, by Sika Chemical Company.
         2) Hydro Active Flex SLV, by De Neef Construction Chemicals, Inc.
         3) Or equal.
      c. Shrinkage limit shall not exceed 4.0 percent in accordance with ASTM D1042.
      d. Minimum elongation of 250 percent in accordance with ASTM D3574.
      e. Minimum tensile strength of 150 psi in accordance with ASTM D3574.
   2. Hydrophilic Acrylate-Ester Resin:
      a. Hydrophilic crack repair system shall be acrylate-ester resin that forms a flexible gasket and increase in volume a minimum of 50 percent when in contact with water.
      b. Products and Manufacturers: Provide one of the following:
         1) Duroseal Multigel 850, manufactured by BBZ USA, Inc.
         2) Superflex AR, by De Neef Construction Chemicals, Inc.
         2) Or equal.

2.11 CONCRETE REPAIR MATERIALS

A. Concrete repair mortar shall be pre-packaged, polymer-modified cementitious repair mortar with the following minimum properties:
   1. Compressive Strength at One Day: 2,000 psi (ASTM C109).
   2. Compressive Strength at 28 Days: 6,000 psi (ASTM C109).
   3. Bond Strength at 28 Days: 1,800 psi (ASTM C882 modified).

B. Products and Manufacturers: Provide one of the following:
   1. Five Star Structural Concrete, by Five Star Products, Inc. Use formulation recommended by manufacturer for the specific application conditions.
   2. SikaTop 122 Plus, SikaTop 123 Plus, SikaTop 111 Plus, or Sikacem 133, by Sika Corporation. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.

3. Emaco S88-CA or S66-CR, by Master Builders Inc. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.
4. Verticoat, Verticoat Supreme, or Euco SR-VO, by Euclid Chemical Company. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.
5. Or equal.

C. Cement Mortar: Shall consist of mix of one part cement to 1.5 parts sand with sufficient water to form trowelable consistency. Minimum compressive strength at 28 days shall be 4,000 psi. Where required to match the color of adjacent concrete surfaces, blend white portland cement with standard portland cement so that, when dry, patching mortar matches the color of surrounding concrete.

2.12 CHEMICAL HARDENER

A. Provide clear chemical hardener of fluosilicate family.

B. Product and Manufacturer: Provide one of the following:
1. Lapidolith, by Sonneborn ChemRex Inc.
2. Hornolith, by A.C. Horn, Inc.
3. Or equal.

2.13 SHAKE-ON METALLIC HARDENER

A. Provide metallic hardener formulated, processed, and packaged under stringent quality control at metallic hardener manufacturer-owned and -controlled factory. Hardener shall be a mixture of specially-processed and -graded aggregate, selected portland cement, and plasticizing agents.

B. Product and Manufacturer: Provide one of the following:
1. Euco-Plate H.D., by Euclid Chemical Company.
2. Masterplate 200, by Master Builders, Inc.
3. Or equal.

2.14 VAPOR RETARDER

A. Vapor Retarder:
1. Vapor retarder membrane shall comply with the following.
   a. Water Vapor Transmission Rate, ASTM E96: 0.04 perms or lower.
   b. Water Vapor Retarder, ASTM E1745: Meets or exceeds Class C.
   c. Thickness of Retarder (plastic), ACI 302 1R: Not less than 10 mils.
2. Products and Manufacturers: Provide one of the following:
   a. Stego Wrap 10-mil Vapor Retarder, by Stego Industries LLC.
   b. Griffolyn 10-mil, by Reef Industries.
   c. Moistop Ultra, by Fortifiber Industries.
   d. Or equal.

B. Accessories:
1. Provide accessories by same manufacturer as vapor retarder.
2. Seam Tape:
   a. Tape shall have water vapor transmission rate (ASTM E96) of 0.3 perms or lower.
   b. Products and Manufacturers: Provide one of the following:
      1) Stego Tape by Stego Industries LLC.
      2) Griffolyn Fab Tape by Reef Industries.
      3) Moistop Tape by Fortifiber Industries.
      4) Or equal.
3. Vapor Proofing Mastic:

a. Mastic shall have a water vapor transmission rate ASTM E96, 0.3 perms or lower.

4. Pipe Boots:
   a. Construct pipe boots for vapor retarder penetrations from vapor barrier material, pressure sensitive tape, mastic, or a combination thereof, in accordance with manufacturer's recommendations.

2.15 SOURCE QUALITY CONTROL

A. Concrete materials may require testing, as directed by Engineer, at any time during the Work if concrete quality is in question. Provide access to material stockpiles and facilities at all times. Tests shall be done at no expense to Owner.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which the Work will be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 CONCRETE MIXING

A. General:
   1. Concrete may be produced at batch plants or by the ready-mixed process. Batch plants shall comply with recommendations of ACI 301 and have sufficient capacity to produce concrete of qualities required and in quantities required to comply with the accepted Progress Schedule. All plant facilities are subject to acceptance of Engineer.
   2. Mixing:
      a. Mix concrete with a rotating type batch machine, except where hand mixing of very small quantities is approved by Engineer.
      b. Remove hardened accumulations of cement and concrete from drum and blades to ensure proper mixing action.
      c. Replace mixer blades upon loss of ten percent of mixer blades' original height.

B. Site Mixing:
   1. When site mixing of concrete is approved by Engineer mix all materials for concrete in a drum-type batch mixer.
      a. For mixers of one cubic yard or smaller capacity, continue mixing at least 1.5 minutes but not more than five minutes after all ingredients are in the mixer, before any part of batch is released.
      b. For mixers of capacity larger than one cubic yard, increase minimum 1.5 minutes of mixing time by 15 seconds for each additional cubic yard or fraction thereof.
   2. Do not exceed mixer manufacturer's published rating of the mixer, or mixer nameplate capacity, for total volume of materials used per batch.
   3. Equip mixer with automatic controls for proportioning materials and proper, measured quantities.
   4. Do not exceed 45 minutes total elapsed time between intermingling of damp aggregates and cement to discharge of completed mix.

C. Ready-Mix Concrete:
   1. Comply with ASTM C94 and the Contract Documents.
      a. Plant Equipment and Facilities: Conform to requirements of NRMCA certification.

b. Mix concrete in revolving-type truck mixers that are in good condition and produce thoroughly-mixed concrete conforming to the Contract Documents.
c. Do not exceed rated capacity of mixer.
d. Mix concrete for minimum of two minutes after arrival at the Site, or as recommended by mixer manufacturer.
e. Do not allow drum to mix while in transit.
f. Mix at proper speed until concrete is discharged from mixer.
g. Maintain adequate facilities at the Site for continuous delivery of concrete at required rates.
h. Provide access to mixing plant for Engineer upon request.

2. When silica fume is used in dry compacted form, comply with the following mix requirements and ensure full dispersion:
   a. For all types of mixing equipment, increase mix times by 40 percent over minimum mix time required to achieve mix uniformity defined in ASTM C94.
   b. For truck-mixed and central-mixed concrete, maximum allowable batch size shall be 80 percent of maximum in accordance with ASTM C94.

D. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery to prevent delay of placing concrete after mixing, or holding dry-mixed materials too long in mixer before the adding water and admixtures.

3.3 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients.

B. Avoid spilling and separation of concrete mixture during transportation.

C. Do not place concrete in which the ingredients have separated.

D. Do not retemper partially set concrete.

E. Use suitable equipment for transporting concrete from mixer to forms.

3.4 PREPARATION FOR CONCRETING

A. Submit to Engineer laboratory trial batch test results for proposed mixes at least 15 days prior to start of Work. Do not begin concrete production until associated laboratory trial batch test result submittal has been approved by Engineer.

B. Notify Engineer a minimum of 24 hours in advance of placing concrete to allow for inspection of form work, joints, waterstops, reinforcement, embedded items, and vapor retarders. The section to be placed shall be fully prepared for concrete placement at the time of notice. Confirm inspection status with Engineer a minimum of 4 hours prior to concrete placement. Do not begin placing concrete until Work is in conformance with the Contract Documents.

C. Subgrade surfaces shall be thoroughly wetted by sprinkling, prior to the placing of concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

D. Reinforcing steel and embedded items shall be completely cleaned of mortar, loose rust, form release compounds, dirt, or other substances which would interfere with proper bonding with

concrete. Protective coatings on embedded aluminum items shall continuously cover the surface to be in contact with concrete. Defects in the coating shall be repaired.

E. Do not place concrete until flow of water entering space to be filled with concrete has been properly stopped or has been diverted by pipes, or other means, and carried out of the forms, clear of the Work. Do not deposit concrete underwater, and do not allow water to rise on concrete surfaces until concrete has attained its initial set. Do not allow water to flow over concrete surface in manner and or velocity that will injure concrete surface finish. Provide temporary pumping or other dewatering operations for removing water as required.

F. Prepare joint surfaces in accordance with Section 03251, Concrete Accessories.

G. Installation of Vapor Retarder:
   1. Provide vapor retarder under slabs-on-grade and outside walls to receive resilient floor finishes, carpet, ceramic and slate tile, chemical resistant coatings, and where shown or indicated on the Drawings.
   2. Install in accordance with manufacturer's instructions, ASTM E1643, and the following:
      a. Unroll vapor retarder with longest dimension parallel with direction of the pour.
      b. Lap vapor retarder over footings and seal to foundation walls.
      c. Overlap vapor retarder joints by six inches and seal with vapor retarder manufacturer's tape.
      d. Seal penetrations, including pipes, in accordance with vapor retarder manufacturer's instructions.
      e. Penetration of vapor retarder is not allowed except for reinforcing steel and permanent utilities.
      f. Repair damaged areas of vapor retarder by providing, for each damaged area, patch of vapor retarder material and overlapping damaged area with the patch by six inches on each side, and securely and continuously taping all four sides of patch to undamaged vapor retarder.

3.5 CONCRETE PLACEMENT

A. General:
   1. Place concrete continuously, so that no concrete will be placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. If section cannot be placed continuously, provide construction joints in accordance with Section 03251, Concrete Accessories.
   2. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to action that may cause segregation.
   3. Screed concrete that is to receive other construction to proper level to avoid excessive skimming or grouting.
   4. Do not use concrete that becomes non-plastic and unworkable, or does not conform to required quality limits, or that has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the Site and dispose of it in conformance with Laws and Regulations.
   5. Do not place concrete until forms, bracing, reinforcing, and embedded items are each in final position and secure.
   6. Do not place footings in freezing weather unless adequate precautions are taken against frost action.
   7. Do not place footings, piers or pile caps on frozen soil.
   8. Unless otherwise instructed, place concrete only when Engineer is present.
   9. Allow minimum of three days between adjoining concrete placements. At expansion joints, allow minimum of one day between adjoining concrete placements.

B. Bonding for Next Concrete Pour:

1. Prepare for bonding of fresh concrete to concrete that has set but is not fully cured, as follows:
    a. Thoroughly wet the surface, but allow no free-standing water.
    b. For horizontal surfaces place a six-inch layer of Construction Joint Grout, as specified in Section 03600, Grouting, over the hardened concrete surface.
    c. Place fresh concrete before the grout has attained its initial set.
2. Accomplish bonding of fresh concrete to fully cured, hardened, existing concrete by using a bonding agent as specified in Section 03251, Concrete Accessories.

C. Concrete Conveying:
1. Handle concrete from point of delivery at the Site, transfer to concrete conveying equipment, and transfer to locations of final deposit as rapidly as practical by methods that prevent segregation and loss of concrete mix materials.
2. Provide mechanical equipment for conveying concrete to ensure continuous flow of concrete at delivery end of conveyor. Provide runways for wheeled concrete conveying equipment from concrete delivery point to locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice, and other deleterious materials.
3. Do not use chutes for distributing concrete, unless accepted by Engineer.
4. Pumping concrete is allowed, however do not use aluminum pipe for conveying concrete.

D. Placing Concrete into Forms:
1. Deposit concrete in forms in horizontal layers not deeper than 18 inches each and in manner that avoids inclined construction joints. Where placement consists of several layers, place concrete at such rate that concrete being integrated with fresh concrete while still plastic.
2. Do not allow concrete to free-fall within the form from height exceeding four feet. Where high-range water reducer is used to extend slump to at least six inches, maximum allowable free-fall of concrete is six feet. Use “elephant trunks” to prevent free-fall and excessive splashing of concrete on forms and reinforcing. Discontinue free-falls in excess of four feet if there is evidence of segregation.
3. Remove temporary spreaders in forms when concrete placing has reached elevation of such spreaders.
4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidating concrete in accordance with requirements of ACI 301. Vibration of forms and reinforcing is not allowed unless otherwise accepted by Engineer.
5. Where height of concrete placement in walls exceeds 14 feet, provide temporary windows in formwork to facilitate vibration. Properly close temporary windows when height of concrete approaches windows. Determine location, size, and spacing of temporary windows to suit equipment used.
6. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly-spaced locations not farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate the layer of concrete and at least six inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcing and other embedded items without causing segregation of concrete mix.
7. Do not place concrete in beam and slab forms until concrete previously placed in columns and walls is no longer plastic.
8. Prevent voids in the concrete. Force concrete under pipes, sleeves, openings, and inserts from one side until visible from the other side.

E. Placing Concrete Slabs:
1. Deposit and consolidate concrete slabs in continuous operation, within limits of construction joints, until placing of a slab panel or section is completed.

2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcing and other embedded items and into corners.
3. Consolidate concrete placed in beams and girders of supported slabs, and against bulkheads of slabs on ground, as specified in this Article for formed concrete structures.
4. Bring slab surfaces to correct elevation and level. Smooth the surface, leaving surface free of humps or hollows. Do not sprinkle water on surface while concrete is plastic. Do not disturb slab surfaces prior to commencing concrete finishing.
5. Where slabs are placed in conditions of high temperature or wind that could lead to formation of plastic shrinkage cracks, provide evaporation retardant applied in accordance with retardant manufacturer's recommendations.

F. Quality of Concrete Work:
1. Concrete shall be solid, compact, and smooth, and free of laitance, cracks, and cold joints.
2. Concrete for liquid-retaining structures, and concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
3. Cut out and properly replace to extent directed by Engineer, or repair to satisfaction of Engineer, defects as defined in 3.12. Thin patches or plastering are unacceptable.
4. Leaks through concrete that exhibit flowing water, and cracks, holes, or other defective concrete in areas of potential leakage, shall be repaired and made watertight.
5. Repair, removal, and replacement of defective concrete as directed by Engineer shall be at no additional cost to Owner.

G. Cold Weather Placing:
1. Protect concrete Work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures, in compliance with ACI 306.1 and the Contract Documents.
2. When air temperature has fallen to or may be expected to fall below 40 degrees F, provide adequate means to maintain temperature in area where concrete is being placed between 50 degrees F and 70 degrees F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain temporary heating and protection as necessary so that ambient temperature does not fall more than 30 degrees F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
3. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing for concrete as required to obtain concrete mixture temperature not less than 55 degrees F and not more than 85 degrees F at point of placement.
4. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Before placing concrete, verify that forms, reinforcing, and adjacent concrete surfaces are entirely free of frost, snow, and ice.
5. Do not use salt or other materials containing antifreeze agents. Do not use chemical accelerators or set-control admixtures unless approved by Engineer and tested in mix design proposed for use.

H. Hot Weather Placing:
1. When hot weather conditions exist that would impair the quality and strength of concrete, place concrete in compliance with ACI 305.1 and the Contract Documents.
2. When ambient air temperature is at or above 90 degrees F and rising, cool ingredients before mixing concrete to maintain concrete temperature at time of placement below 80 degrees F. When ambient air temperature is at or above 90 degrees F and falling, cool the ingredients before mixing concrete to maintain concrete temperature at time of placement below 85 degrees F. In no case shall the concrete temperature at time of placement exceed 90 degrees F.

3. Mixing water may be chilled, or chopped ice may be used to control concrete temperature provided the water equivalent of ice is calculated in total amount of mixing water. If required, reduce the time from addition of mix water to placement, or use set-retarding admixture.
4. Cover reinforcing materials with water-soaked burlap if ambient air temperature becomes too hot, so that reinforcing material temperature does not exceed ambient air temperature immediately before embedment of reinforcing in concrete.
5. Wet forms thoroughly before placing concrete.
6. Do not place concrete at temperature that causes difficulty from loss of slump, flash set, or cold joints.
7. Obtain Engineer's approval of substitute methods and materials proposed for use.

I. Underwater Placing:
1. Concrete placement in water will be allowed if conditions render it impossible or inadvisable to dewater excavations or liquid-retaining structures before placing concrete, and only when allowed by Engineer in writing.
2. Revise and submit concrete mix design to suit underwater placement, and obtain Engineer's approval before commencing underwater placement of concrete. Deposit concrete by tremie method or other suitable means in continuous placement to prevent forming layers or intrusion of water.

3.6 FINISHING OF FORMED SURFACES

A. Standard Form Finish:
1. Standard form finish shall be basically smooth and even, but is allowed to have texture imparted by the form material used. Repair defects in accordance with the Contract Documents.
2. Use standard form finish for the following:
   a. Exterior vertical surfaces from foundation up to one foot below grade.
   b. Vertical surfaces not exposed to view.
   c. Other areas shown or indicated.

B. Smooth Form Finish:
1. Produce smooth form finish by selecting form materials that will impart smooth, hard, uniform texture. Arrange panels in orderly and symmetrical manner with minimum of seams. Repair and patch defective areas in accordance with the Contract Documents.
2. Use smooth form finish for the following:
   a. Exterior surfaces exposed to view.
   b. Surfaces to be covered with coating material. Coating material may be applied directly to concrete or may be a covering bonded to concrete such as waterproofing, dampproofing, painting, or other similar system.
   c. Interior vertical surfaces of liquid-containers.
   d. Interior and exterior exposed beams and undersides of slabs.
   e. Surfaces to receive abrasive blasted finish.
   f. Surfaces to receive smooth rubbed or grout cleaned finish.
   g. Other areas shown or indicated.

D. Grout Cleaned Finish:
1. Provide grout cleaned finish to concrete surfaces that have received smooth form finish and where defects have been repaired, as follows:
   a. Combine one part portland cement to 1.5 parts fine sand by volume, and mix with water to consistency of thick paint. Blend standard portland cement and white portland cement, in proportions determined by trial patches, so that final color of dry grout will closely match adjacent concrete surfaces.

b. Thoroughly wet concrete surface and apply grout uniformly by brushing or spraying immediately to wetted surfaces. Scrub surface with cork float or stone to coat surface and fill surface holes. Remove excess grout by scraping, followed by rubbing with clean burlap to remove visible grout film. Keep grout damp during setting period by using fog spray on surface for at least 36 hours after final rubbing. Complete each area the same day the area is started, with limits of each area being natural breaks in the finished surface.

2. Use grout cleaned finish for the following:
   a. Interior exposed walls and other vertical surfaces.
   b. Exterior exposed walls and other vertical surfaces down to one foot below grade.
   c. Interior and exterior horizontal surfaces.
   d. Interior exposed vertical surfaces of liquid-containing structures down to one foot below normal operating liquid level.
   e. Other areas shown.

E. Abrasive Blasted Finish:
1. Provide abrasive blasted finish where shown or indicated.
2. Where abrasive blasted finish is required, apply finish to smooth formed finish after end of curing period, with defects repaired, to match approved finish provided on mock-up or Sample panel, as applicable.
3. Heavy Abrasive Blasted Finish: Abrasive blast to uniformly expose coarse aggregate.
4. Light Abrasive Blasted Finish: Abrasive blast to uniformly expose fine aggregate.

F. Related Unformed Surfaces:
1. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise shown or indicated.

3.7 SLAB FINISHES

A. Float Finish:
1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently. Check and level the surface plane to tolerance not exceeding 1/4-inch in ten feet when tested with a ten-foot straightedge placed on surface at not less than two different angles. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to uniform, smooth, granular texture.
2. Use float finish for the following:
   a. Interior exposed horizontal surfaces of liquid-containing structures, except those to receive grout topping.
   b. Exterior below-grade horizontal surfaces.
   c. Surfaces to receive additional finishes, except as shown or indicated.

B. Trowel Finish:
1. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over the surface.
2. Consolidate concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten foot straight edge. Grind smooth surface defects that would otherwise project through applied floor covering system.
3. Use trowel finish for the following:
   a. Interior exposed slabs, unless otherwise shown or indicated.
   b. Slabs that receive one of the following: resilient flooring, carpeting, or ceramic tile.

C. Non-Slip Broom Finish:

1. Immediately after float finishing, slightly roughen concrete surface by brooming in direction perpendicular to main traffic route. Use fine fiber-bristle broom, unless otherwise directed by Engineer. Coordinate required final finish with Engineer before applying finish.
2. Use non-slip broom finish for the following:
    a. Exterior exposed horizontal surfaces subject to lightweight foot traffic.
    b. Interior and exterior concrete steps and ramps.

D. Special Finish, Troweled Polyester Composition:
1. For floors receiving troweled polyester composition finish, the following apply:
    a. Provide wood float finish.
    b. Elevation shall be uniform within 1/4-inch tolerance in ten feet.
    c. Use approved curing and hardening compound or proper moist curing procedures.
    d. Cure slabs for 21 days minimum prior to topping.
    e. Protect slabs against oil and greases. Remove from slab surface dripping, flaking, and loose substances and other bonded foreign particles that might prevent adhesion of composition.
    f. Patch and repair other floor imperfections in accordance to finish manufacturer's recommendations.

E. Shake-On Metallic Finish:
1. For each slab shown or indicated to receive shake-on metallic finish, provide application of shake-on metallic hardener at rate of two pounds per square foot. First shake shall comprise two-thirds of specified quantity of hardener. Provide first application after initial floating operation, unless climatic conditions dictate earlier application. Shake-on metallic hardener shall be floated in the second application. Surface shall be floated again after second application to properly bond hardener to base concrete slab. Surface shall then be troweled at least twice to smooth, dense finish.
2. Furnish field service upon five days notice by the hardener manufacturer to assist Contractor in obtaining maximum benefits of product under prevailing conditions at the Site. Hardener manufacturer's representative shall attend concrete coordination conference required in Article 1.3 of this Section.
3. Use shake-on metallic hardener finish with Class "C" concrete for slabs shown or indicated on the Drawings as receiving this finish.
4. Protect slabs against oil and greases. Remove from slab surface dripping, flaking, or loose substances and other bonded foreign particles that might prevent adhesion of finish.
5. Patch and repair other floor imperfections in accordance with hardener manufacturer's recommendations.

F. Scratched Finish:
1. After providing float finish, roughen concrete surface with rake before concrete's final set. Amplitude of surface shall be minimum of 1/4-inch.
2. Provide scratched finish for the following:
    a. Horizontal surfaces that will receive grout topping or concrete equipment pad.
    b. Surfaces so indicated on the Drawings or elsewhere in the Contract Documents.

3.8 CONCRETE CURING AND PROTECTION

A. General:
1. Protect freshly placed concrete from premature drying, excessive cold or hot temperatures, and maintain without drying at relatively constant temperature for period necessary for hydration of cement and proper hardening of concrete.
2. Start curing after placing and finishing concrete, as soon as free moisture has disappeared from concrete surface. Keep surface continuously moist during entire curing period. Cure for a minimum of 10 days and in accordance with requirements of ACI 301 and ACI 308.1.

For concrete sections over 30-inches thick, the curing period shall be for a minimum of 14 days. Avoid rapid drying at end of final curing period.

3. For curing, use water that is free of impurities that could etch or discolor exposed concrete surfaces.
4. Confine water for curing to area being cured.

B. Curing Methods: Curing methods are specified below. Curing methods to be used on each type of concrete surface are specified elsewhere in this Article.
   1. Water Curing. Cure by one of the following methods:
      a. Keep concrete surface continuously wet.
      b. Ponding or immersion.
      c. Continuous water-fog spray.
      d. Covering concrete surface with curing mats, thoroughly saturating mats with water, and keeping mats continuously wet with sprinklers or porous hoses. Place curing mats to cover concrete surfaces and edges with four-inch horizontal lap over adjacent mats; provide eight-inch lap over adjacent mats at vertical surfaces. If necessary, weigh down curing cover to maintain contact with concrete surface.
   2. Form Curing. Cure by one of the following methods:
      a. Forms shall be maintained and loosened during curing period.
      b. Immediately after forms are loosened or removed, continue with the required curing method as applicable, for remainder of curing period.
      c. Where wood forms are kept in place, apply water to keep forms wet.
   3. Moisture Retaining Cover Curing. Cure as follows:
      a. Cover concrete surfaces with the required moisture retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least three inches and sealed using waterproof tape or adhesive. Immediately repair holes or tears during curing period using cover material and waterproof tape.
   4. Liquid Compound Curing. Cure as follows:
      a. Unless otherwise approved by Engineer, provide water curing or form curing. Request to use liquid curing compound will be considered by Engineer on case-by-case basis. Construction joints, formed surfaces prior to receiving specified form finish, and concrete to receive surface treatment where surface treatment will be bonded to concrete surface (such as, but not limited to grout fill, hardener, coatings, lining, water repellent, painting, resilient flooring, terrazzo flooring, ceramic tile, quarry tile, chemical resistant coatings, or other applications) shall be water-cured or form-cured.
      b. In liquid-retaining structures, provide water curing or form curing, unless other curing method is approved by Engineer. Requests to use liquid curing compound will be considered by Engineer on case-by-case basis. Request shall provide valid construction reason or safety reason for using liquid compound curing including reason why other curing methods are not viable.
      c. Apply curing compounds immediately after final finishing or after terminating water curing. Apply curing compound in continuous operation by power spray equipment in accordance with curing compound manufacturer's directions. If areas are subjected to rainfall within three hours after completing curing compound application, area shall be recoated. Maintain coating continuity and repair areas damaged during curing period.
      d. When liquid curing compound is used, apply first coat of liquid curing compound at compound manufacturer's recommended coverage rate, and subsequently apply second coat at identical rate, thus providing twice the curing compound manufacturer's recommended coverage.
      e. At end of curing period, remove liquid curing compound where required.

C. Formed Surfaces: Use the following curing methods:
   1. Walls That Will Retain Liquid or That are Under Ground Surface:

a. If forms are wood, form curing is allowed for entire curing period. If forms are steel, form curing is allowed for maximum of three days after which forms shall be removed so that concrete is free of the forms for remainder of the curing process.
b. Immediately after the forms are loosened or removed, continue with water curing for remainder of curing period.
c. When wall surface will not receive surface treatment and when allowed by Engineer, use of liquid curing compound is allowed. Before using liquid compound curing, use water curing or form curing for at least the first three days of curing.

2. Formed Slab Underside and Beam Surfaces Where Will Retain Liquid:
a. Form curing is allowed for the full curing period.
b. Immediately after forms are loosened or removed, continue with water curing for remainder of curing period.
c. When slab surface will not receive surface treatment and when allowed by Engineer, use of liquid curing compound is allowed.

3. Vertical Joint Surfaces and Surfaces to Receive Surface Treatment:
a. Form curing is allowed for entire curing period.
b. Immediately after forms are loosened or removed, continue with water curing for remainder of curing period.

4. Cure other formed surfaces using an appropriate curing method specified in the Contract Documents.

D. Unformed Surfaces: Treat with one of the following curing methods:
1. Slabs and Mats That Will Retain Liquid or are Below Ground Surface:
a. Water curing.
b. Moisture-retaining cover curing when allowed by Engineer.
c. When slab or mat surface will not receive surface treatment and when allowed by Engineer, use of liquid curing compound is allowed. Before using liquid compound curing, use water curing or form curing for at least the first three days of curing.

2. Construction Joint Surfaces and Slab and Mat Surfaces to Receive Surface Treatment.
a. Water curing.
b. Moisture-retaining cover curing.

3. Cure other formed surfaces using an appropriate curing method specified in the Contract Documents.

E. Temperature of Concrete During Curing:
1. When ambient temperature is 40 degrees F or less, continuously maintain concrete temperature between 50 degrees F and 70 degrees F throughout curing period. When necessary, before concrete placing provide for temporary heating, covering, insulation, or housing as required to continuously maintain specified temperatures and moisture conditions throughout concrete curing period. Provide cold weather protection in accordance with requirements of ACI 306.1.
2. When the ambient temperature is 80 degrees F and above, or during other climatic conditions that would cause too-rapid drying of concrete, before starting concrete placing, provide wind breaks and shading as required, and fog spraying, wet sprinkling, or moisture retaining coverings as required. Continuously protect concrete throughout concrete curing period. Provide hot weather protection in accordance with requirements of ACI 305.1, unless otherwise specified.
3. Maintain concrete temperature as uniformly as possible, and protect from rapid ambient temperature changes. Avoid concrete temperature changes that exceed five degrees F in one hour and 50 degrees F in 24-hour period.

F. Protection:
1. During curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and damage by rain and flowing water. Protect finished concrete surfaces from damage by subsequent construction operations.

3.9 CONCRETE INSTALLATION TOLERANCES

A. Installation Tolerances:
   1. Concrete placement tolerances, unless otherwise specified in the Contract Documents, shall be in accordance with ACI 117.
   2. Notify Engineer in writing when concrete placement does not conform with required tolerances, as soon as the condition is known to Contractor.
   3. When concrete installation does not conform to required tolerances, do not repair or correct by grinding unless specified in the Contract Documents or approved by Engineer in writing.
   4. Verification Measurements:
      a. If surfaces where tolerances are in question, obtain measurements to verify conformance with tolerances in manner acceptable to Engineer.
      b. If surfaces tolerances are in question, cost of obtaining measurements shall be at no additional cost to the Owner.
      c. Before obtaining measurements, obtain Engineer's acceptance of method proposed for obtaining measurements.
      d. After obtaining measurements, submit measurements to Engineer.
   5. Submit with verification measurements submittal proposed method to rectify out-of-tolerance concrete. Do not start repair Work without obtaining Engineer's approval.

3.10 FIELD QUALITY CONTROL

A. Field Testing Services:
   1. Owner will employ testing laboratory to perform field quality control testing for concrete. Engineer will direct the testing requirements.
   2. Testing laboratory will make standard compression test cylinders and entrained air tests as specified in this Article, under observation of Engineer or Resident Project Representative.
   3. Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.
   4. Contractor shall provide all curing and necessary cylinder storage facilities in accordance with ASTM C31.

B. Quality Control Testing During Construction:
   1. Perform sampling and testing for field quality control during placement of concrete, as follows:
      a. Sampling Fresh Concrete: ASTM C172.
      b. Slump: ASTM C143; one test for each concrete load at point of discharge.
      c. Concrete Temperature: ASTM C1064; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.
      d. Air Content: ASTM C231; one for every two concrete load at point of discharge, and when a change in the concrete is observed.
      e. Unit Weight: ASTM C138; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
      f. Compression Test Specimens:
         1) In accordance with ASTM C31; make one set of compression cylinders for each 50 cubic yards of concrete, or fraction thereof, of each mix design placed each day. Each set shall be four standard cylinders, unless otherwise directed by Engineer.
         2) Cast, store, and cure specimens in accordance with ASTM C31.
         3) Test and record the following when cylinders are cast: slump, concrete temperature, air content, and unit weight.
      g. Compressive Strength Tests:

1) In accordance with ASTM C39; one specimen tested at seven days, and two specimens tested at 28 days. Test fourth cylinder if needed to verify test results. If 4-inch by 8-inch cylinders are used, three specimens shall be tested at 28 days.
2) Adjust mix design if test results are unsatisfactory and resubmit for approval.
3) Concrete that does not comply with strength requirements will be considered as defective Work.

h. Water/Cementitious Materials Ratio: Perform one test from each sample from which compression test specimens are taken, in accordance with AASHTO TP23.

i. Within 24 hours of completion of test, testing laboratory will submit certified copy of test results to Contractor and Engineer.

C. Evaluation of Field Quality Control Tests:

1. Do not use concrete delivered to final point of placement having slump, concrete temperature, total air content or unit weight outside specified values.

2. Water/Cementitious Materials Ratio:

a. When water content testing indicates water/cementitious materials ratio to exceed specified requirements by greater than 0.02, remaining batches required to complete concrete placement shall have water content decreased in the mix and water reducing admixture dosage increased as required to bring subsequently-batched concrete within specified water/cementitious materials ratio.

b. Perform additional testing to verify compliance with specified water/cementitious materials ratio.

c. Do not resume concrete production for further concrete placement until Contractor has identified cause of excess water in the mix and revised batching procedures, or adjusted the mix design (and obtained Engineer's associated approval) to bring water/cementitious materials ratio into conformance with the Contract Documents.

3. Compressive Strength:

a. Compressive strength tests for laboratory-cured cylinders will be acceptable if the averages of all sets of three consecutive compressive strength tests results equal or exceed specified 28-day design compressive strength of the associated type or class of concrete, and no individual strength test falls below required compressive strength by more than 500 psi.

b. Questionable Field Conditions During Concrete Placement:

1) Where questionable field conditions exist during concrete placement or immediately thereafter, strength tests of specimens cured under field conditions will be required by Engineer to check adequacy of curing and protecting of concrete placed. Specimens shall be molded at the same time and from the same samples as laboratory-cured specimens.
2) Provide improved means and procedures for protecting concrete when 28-day compressive strength of field-cured cylinders is less than 85 percent of companion laboratory cured cylinders.
3) When laboratory-cured cylinder strengths are appreciably higher than minimum required compressive strength, field-cured cylinder strengths need not exceed minimum required compressive strength by greater than 500 psi even though the 85 percent criterion may not be met.
4) If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength, or if tests of field-cured cylinders indicate deficiencies in protection and curing, provide additional measures to ensure that load-bearing capacity of the structure is not jeopardized or impaired. If likelihood of low-strength concrete is confirmed and evaluations indicate load-bearing capacity may have been reduced, perform tests of cores from the concrete in question at Contractor's expense.

c. If compressive strength tests fail to indicate compliance with minimum requirements of the Contract Documents, concrete represented by such tests will be considered defective.

D. Testing Concrete Structure for Strength:
   1. When there is evidence that strength of in-place concrete does not comply with the Contract Documents, Contractor shall employ the services of concrete testing laboratory to obtain cores from hardened concrete for compressive strength determination. Cores and tests shall comply with ASTM C42 and the following:
      a. Obtain at least three representative cores from each concrete member or suspect area of concrete at locations directed by Engineer.
      b. Strength of concrete for each series of cores will be acceptable if average compressive strength is at least 85 percent of specified compressive strength and no single core is less than 75 percent of required 28-day required concrete compressive strength.
      c. Testing laboratory shall submit test results to Engineer on same day that tests are completed. Include in test reports Project name and number (if any), date of sampling and testing, Contractor name, name of concrete testing laboratory, exact location of test core in the Work, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength, and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of concrete as placed, and moisture condition of the core at time of testing.
   2. Fill core holes solid with non-shrink grout in accordance with Section 03600, Grouting, and finish to match adjacent concrete surfaces.
   3. If results of core tests are unacceptable or if it is impractical to obtain cores, perform static load test and evaluations complying with ACI 318 and ACI 350, as directed by Engineer.

E. Concrete Tolerance Verification Measurements: Refer to Article 3.9 of this Section.

F. Supplier's Services:
   1. Water-Reducing Admixture Manufacturer: Furnish services of qualified concrete technician employed by admixture manufacturer to assist in proportioning concrete for optimum use of admixture. Concrete technician shall advise on proper addition of admixture to concrete and on adjustment of concrete mix proportions to meet changing conditions at the Site.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Temporary Openings:
   1. Openings in concrete walls and slabs required for passage of Work are allowed only upon approval of Engineer.
   2. Temporary openings made in concrete shall be provided with waterstop in below-ground or liquid-retaining members and structures. Reinforcement going through and around the opening shall be made continuous to provide continuity and shall be approved by the Engineer.
   3. Temporary openings that remain in concrete structures shall be filled with the same class of concrete as the adjoining construction, after the Work causing need for temporary opening is complete, unless otherwise shown or directed by Engineer. Mix, place, and cure concrete as specified in this Section to blend with in-place construction. Provide miscellaneous concrete filling shown or required to complete the Work.

B. Bases or Pads for Piping, Panels, and Equipment:
   1. Unless specifically shown or indicated otherwise, provide concrete bases or pads for equipment, floor-mounted panels, and floor-mounted supports for piping and similar construction. Provide all concrete pad and base Work not specifically included under other Sections.
   2. Dimensions and Elevations:

a. Coordinate and construct bases and pads to dimensions shown or indicated, or as required to comply with equipment, panel, or piping manufacturer's requirements and elevations indicated on the Drawing.
b. Unless otherwise shown or indicated, place concrete bases for equipment up to one-inch below the equipment manufacturer's base or mounting plate.
c. Where specific dimensions or elevations are not shown or indicated, bases and pads shall be six inches thick and extend three inches outside dimensions of the equipment, panel, or supports.

3. Finish: Bases and pads outside of areas to receive non-shrink grout shall have smooth trowel finish, unless special finish such as terrazzo, ceramic tile, quarry tile, or heavy-duty concrete topping is required. In such cases, provide appropriate concrete finish. Surfaces of bases and pads to receive non-shrink grout shall have broom finish.

C. Curbs:
1. Provide monolithic finish to interior curbs by stripping forms while concrete is still green followed by steel-troweling surfaces to hard, dense finish with corners, intersections, and terminations slightly rounded.
2. Exterior curbs shall have rubbed finish for vertical surfaces and broomed finish for top surfaces.

D. Steel Pan Stairs:
1. Provide concrete fill for steel pan stair treads, landings, and associated items. Screed, tamp, and finish concrete surfaces as shown or indicated.
a. Cast into the concrete fill safety inserts and accessories as shown or indicated.

3.12 REPAIR OF CONCRETE PLACED UNDER THIS CONTRACT

A. Repair of Formed Surfaces:
1. Repair the following defects in all formed finishes:
a. Spalls, air bubbles, rock pockets, form depressions, and other defects that are more than 1/4-inch in depth.
b. Holes from tie rods and other form tie systems.
c. Fins, offsets, and other projections that extend more than 1/4-inch beyond designated concrete member surface.
d. Structural cracks, as defined by Engineer.
e. Non-structural cracks greater than 0.010-inch wide as defined by Engineer. In liquid-retaining structures, elevated slabs subject to the elements or washdowns, below-grade members, and cracks that evidence leakage. Where it is not possible to verify whether a crack is leaking, repair the crack.
2. Repair the following defects in smooth-finish surfaces, in addition to those listed above in this Section:
a. Spalls, air bubbles, rock pockets, form depressions, and other defects that extend to more than 1/2-inch in width in any direction, no matter how deep.
b. Spalls, air bubbles, rock pockets, form depressions, and other defects of any size that exceed three in number in a 12-inch by 12-inch area, or 12 in number in a three-foot by three-foot area.
c. Fins, offsets, and other projections shall be completely removed and smoothed.
d. Scratches and gouges in concrete surface.
e. Texture and color irregularities. In liquid-retaining surfaces, texture and color irregularities need not be repaired when greater than 12 inches below minimum normal operating liquid surface elevation, except where such defects are indicative of reduced durability.
3. Where smooth rubbed or grout cleaned finish is specified, minor surface defects repairable by the finishing process need not be repaired prior to finish application, when approved by Engineer.

B. Method of Repair of Formed Surfaces:
   1. Immediately after removing forms, repair and patch defective areas with cement mortar or concrete repair mortar as directed by Engineer. Make repairs made to liquid-retaining structures and below-grade surfaces with repair mortar only. Repair form tie holes in liquid-retaining or below-grade surfaces with non-shrink grout in accordance with Section 03600, Grouting.
   2. Honeycombs, Rock Pockets, and Holes Left by Tie Rods and Bolts:
      a. Cut out honeycomb, rock pockets, voids, and holes left by tie rods and bolts, down to solid concrete but, in no case, to depth less than one-inch for cement mortar and 1/2-inch for repair mortar. Make edges of cuts perpendicular to concrete surface.
      b. Before placing cement mortar, thoroughly clean and brush-coat area to be patched with specified bonding agent.
      c. When using concrete repair mortar, use of bonding agent is optional; prepare the surface and place mortar in accordance with mortar manufacturer's recommendations.
      d. Repairs at exposed-to-view surfaces shall match the color of surrounding concrete, except color matching is not required for interior surfaces of liquid-retaining surfaces up to one foot below typical minimum liquid level. Impart texture to repaired surfaces to match texture of existing adjacent surfaces. Provide test areas at inconspicuous locations to verify mixture, texture, and color match before proceeding with patching.
      e. Compact mortar in place and strike off slightly higher than the surrounding surface.
   3. Structural Cracks: Pressure-grout structural cracks using injectable epoxy installed using pressurized system. Apply in accordance with epoxy manufacturer's directions and recommendations.
   4. Non-structural Cracks: Shall be pressure-grouted using hydrophobic or hydrophilic resin. Install in accordance with resin manufacturer's directions and recommendations.
   5. Determination of the crack type shall be made by the Engineer.
   6. Holes Through Concrete:
      a. Using plunger-type gun or other suitable device, fill holes extending through concrete from least-exposed face, using flush stop held at exposed face; completely fill the hole with specified repair material.
      b. At below-grade and liquid-containing members, fill holes with concrete repair mortar and use color-matched cement mortar for outer two inches at exposed-to-view surfaces.
   7. Where powerwashing or scrubbing is not adequate, abrasive blast exposed- to-view surfaces that require removal of stains, grout accumulations, sealing compounds, and other substances marring the surfaces. Use sand finer than No. 30 and air pressure from 15 to 25 psi.

C. Repair of Unformed Surfaces:
   1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to specified tolerances for each surface and finish. Correct low and high areas in accordance with this Section.
   2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using template having the required slope. Correct high and low areas in accordance with this Section.
   3. Repair finish of unformed surfaces containing defects that adversely affect concrete durability. Surface defects include crazing, cracks in excess of 0.01-inch wide, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
   4. Repair structural cracks in all structures and non-structural cracks in liquid-retaining structures. In liquid-retaining structures, where dry face of concrete member can be observed, repair all cracks evidencing any rate of water flow through crack. Where dry face of member cannot be observed, repair all cracks.

D. Methods of Repair of Unformed Surfaces:

1. Correct high areas in unformed surfaces by grinding, after concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.
2. Correct low areas in unformed surfaces, during or immediately after completion of surface finishing, by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Where repairs are required and concrete has already set, sawcut around perimeter of area to be repaired to depth of 1/2-inch and remove concrete so that minimum thickness of repair is 1/2-inch. Apply specified concrete repair mortar in accordance with repair mortar manufacturer's directions and recommendations.
3. Repair defective areas, except random cracks and single holes not exceeding one-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. Minimum thickness of repair shall be 1.5 inches. Dampen concrete surfaces in contact with patching concrete and brush with specified bonding agent. Place patching concrete while bonding agent is tacky. Mix patching concrete of same materials and proportions to provide concrete of same classification as original, adjacent concrete. Place, compact, and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
4. Repair isolated, random, non-structural cracks (in members that are not below grade or liquid-retaining), and single holes not greater than one-inch diameter, by dry-pack method. Groove top of cracks, and cut out holes to sound concrete, and clean repair area of dust, dirt, and loose particles. Dampen all cleaned concrete surfaces and brush with the specified bonding agent. Place dry-pack before cement grout takes its initial set. Mix dry-pack, consisting of one part portland cement to 2.5 parts fine aggregate passing No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for at least 72 hours.
5. Structural cracks shall be pressure-grouted using injectable epoxy. Apply in accordance with epoxy manufacturer's directions and recommendations.
6. Non-structural cracks in below-grade and liquid-retaining structures shall be pressure-grouted using hydrophilic resin. Apply in accordance with resin manufacturer's directions and recommendations.
7. Determination of crack type will be by Engineer.
8. Ensure that surface is acceptable for flooring material to be installed in accordance with flooring manufacturer's recommendations.

E. Other Methods of Repair:
1. Repair methods not specified in this Section may be used when approved by Engineer.

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SECTION 03350

CONCRETE FINISHES

PART 1- GENERAL

1.01 DESCRIPTION

A. Furnish all materials, labor, and equipment required to provide finishes of all concrete surfaces specified herein and shown on the Drawings.

1.02 RELATED SPECIFICATIONS

A. Section 03100 – Concrete Formwork

B. Section 03300 – Cast-in-Place Concrete

C. Section 03600 – Grout

1.03 PAYMENT

A. Payment for work furnished and installed under this Section shall be included in the lump sum price bid for the Contract, as described in Section 01150 – Measurement and Payment.

1.04 REFERENCES

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
   1. ACI 301 – Specifications for Structural Concrete for Buildings
   2. ACI 318 – Building Code Requirements for Structural Concrete

1.05 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.
   1. Manufacturer's literature on all products specified herein.
      a. Include manufacturer's statement of compatibility with concrete mix including admixtures.
   2. Mock-Up Assembly.
      a. Provide a complete mock-up assembly as referenced on architectural drawings and notes for exposed exterior finish concrete. Provide all work and necessary appurtenances to erect the mock-up wall and associated mock-up support slab.

b. Contractor shall furnish shop drawings in accordance with the contract for the mock-up assembly. Contractor shall not proceed to erect mock-up until approval of shop drawings.
c. The Mock-Up Assembly shall not be a portion of the final work.

PART 2- PRODUCTS

2.01 CONCRETE FLOOR SEALER

A. Interior floor sealer shall be one of the following:
   1. Diamond Clear VOX by the Euclid Chemical Company.
   2. Seal Hard from L&M Construction Chemicals.
   3. Lion Hard from Laticrete International.
   4. Or approved equal.

2.02 NON-METALLIC FLOOR HARDENER

A. The specified non-metallic mineral aggregate hardener shall be formulated, processed, and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a factory-blended mixture of specifically processed graded mineral aggregate, selected Portland cement, and necessary plasticizing agents. The hardener shall be light reflective. Acceptable products shall be one of the following:
   1. Surflex by the Euclid Chemical Company.
   2. Quartzplate FF Light Reflective by Laticrete.
   3. Or approved equal.

2.03 NON-SLIP FLOORING AGGREGATE

A. Non-slip flooring aggregate for non-slip floors shall be non-metallic. Non-slip flooring aggregate shall be one of the following:
   1. Non-Slip by the Euclid Chemical Company.
   2. A-H Alox by Anti- Hydro.
   3. Or approved equal.

PART 3 – EXECUTION

3.01 FINISHES ON FORMED CONCRETE SURFACES

A. After removal of forms, the finishes described below shall be applied in accordance with Article 3.05 - Concrete Finish Schedule. Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. The Engineer shall be the sole judge of acceptability of all concrete finish work.
   1. Type I - Rough: All fins, burrs, offsets, marks and all other projections left by the forms shall be removed. Projections, depressions, etc. below finished grade required to be removed will only be those greater than ¼-inch. All holes left by

removal of ends of ties, and all other holes, depressions, bugholes, air/blow holes or voids shall be filled solid with cement grout after first being thoroughly wetted and then struck off flush. The only holes below grade to be filled will be tie holes and any other holes larger than ¼-inch in any dimension. Honeycombs shall be chipped back to solid concrete and repaired as directed by the Engineer. All holes shall be filled with tools, such as sponge floats and trowels, that will permit packing the hole solidly with cement grout. Cement grout shall consist of one part cement to three parts sand, epoxy bonding agent (for tie holes only) and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. Type II - Grout Cleaned: Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been predampened, a slurry consisting of one part cement (including an appropriate quantity of white cement in order to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Mix proportions shall be submitted to the Engineer after a sample of the work is established and accepted. Any surplus shall be removed by scraping and then rubbing with clean burlap.
3. Type III - Smooth Form Finish: Concrete shall be cast against forms constructed of plywood not less than 5/8 inch thick, or of boards lined with tempered hardboard not less than 3/16 inch thick, or other approved materials. Form material shall not have torn grain, worn edges, patches of holes from previous use, or other defects which would impair the texture of the concrete surface. Form material shall utilize sheets as large as practicable in an orderly and symmetric configuration. Other aspects of the finish shall conform to the requirements of the rough form finish.
4. Type IV - Smooth Rubbed: Where this finish is required, it shall be applied after the completion of the Type III finish. No rubbing shall be done before the concrete is thoroughly hardened and the mortar used for patching is firmly set. A smooth, uniform surface shall be obtained by wetting the surface and rubbing it with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities requires it, the general surface of the concrete shall not be cut into. Corners and edges shall be slightly rounded by the use of the carborundum stone. Brush finishing or painting with grout or neat cement will not be permitted. A 100 square foot example shall be established at the beginning of the project to establish acceptability.

3.02 SLAB AND FLOOR FINISHES

A. The finishes described below shall be applied to floors, slabs, flow channels and top of walls in accordance with Article 3.05 - Concrete Finish Schedule. The Engineer shall be the sole judge of acceptability of all such finish work.
   1. Type "A" - Screeded: This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish

is subsequently to be applied, the surface of the screeded concrete shall be roughened with a concrete rake to 1/2” minimum deep grooves prior to final set.

2. Type "B" - Wood or Magnesium Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a wood or magnesium float or until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finished surface shall be true, even, and free from blemishes and any other irregularities.
3. Type "C" - Cork Floated: This finish shall be similar to Type "B" but slightly smoother than that obtained with a wood float. It shall be obtained by power or band floating with cork floats.
4. Type "D" - Steel Troweled: This finish shall be obtained after completion of a Type "B" finish. When the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. In areas which are to receive vapor barriers and applied roofing, the applicable Specification Sections and Contract Drawings shall be reviewed for the required finishes and degree of flatness. All edges shall be edged with a 1/8-inch tool as directed by the Engineer. The finish shall be brought to a smooth, dense surface, free from defects and blemishes.
5. Type "E" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish. All edges shall be edged with a 1/8-inch tool as directed by the Engineer.
6. Type “G” Hardened Finish: This finish shall be applied after completion of a Type “B” or Type “C” finish and prior to application of a Type “D” finish. Hardeners shall be applied in strict accordance with the manufacturer’s requirements. Hardeners shall be applied using a mechanical spreader. The hardener shall be applied in two shakes with the first shake comprising 2/3 of the total amount. Type “D” finish shall be applied following completion of application of the hardener.
    a. Non-metallic floor hardener shall be applied where specifically required on the Contract Drawings at the rate of 1.5 pounds/ft.2and shall increase floor light reflection a minimum of 60%.
7. Type "H" - Non-Slip Finish: This finish shall be provided by applying a non-slip flooring aggregate concurrently with the application of a Type "E" finish. Application procedure shall be in accordance with manufacturer's instructions. Finish shall be applied where specifically required on the Contract Drawings or specified herein.

3.03 CONCRETE SEALERS

A. Concrete sealers shall be applied where specifically required on the Contract Drawings or specified herein.

B. Sealers shall be applied after installation of all equipment, piping, etc. and after completion of any other related construction activities. Application of sealers shall be in strict accordance with manufacturer's requirements.

C. Sealers shall be applied to all floor slabs not painted and not intended to be immersed.

D. All other floor slabs to receive sealer shall be sealed with concrete floor sealer.

3.04 FINISHES ON EQUIPMENT PADS

A. Formed surfaces of equipment pads shall receive a Type III finish.

B. Top surfaces of equipment pads, except those surfaces subsequently required to receive grout and support equipment bases, shall receive a Type "D" finish, unless otherwise noted. Surfaces which will later receive grout shall, before the concrete takes its final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with irregular indentations in the surface up to 1/2 inch deep.

3.05 CONCRETE FINISH SCHEDULE

ITEM	**TYPE OF FINISH**
EXTERIOR EXPOSED CONCRETE WALLS, CEILINGS, BEAMS, MANHOLES, HAND HOLES, MISCELLANEOUS STRUCTURES AND COLUMNS (INCLUDING TOP OF WALL) TO ONE FOOT BELOW GRADE. ALL OTHER EXPOSED CONCRETE SURFACES NOT SPECIFIED ELSEWHERE	II
EXPOSED EXTERIOR CONCRETE PIERS	IV
ALL INTERIOR FINISH FLOORS OF BUILDINGS AND STRUCTURES.	G
ROOF SLABS	D
EXTERIOR CONCRETE SIDEWALKS, STEPS, RAMPS, DECKS, SLABS ON GRADE AND LANDINGS EXPOSED TO WEATHER	H

+ + END OF SECTION + +

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SECTION 03600

GROUTING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install grout and perform grouting Work.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before grouting Work.

C. Related Sections:
   1. Section 03251, Concrete Accessories.
   2. Section 03300, Cast-In-Place Concrete.

D. Application and Grout Material:
   1. The following is a listing of grouting applications and the corresponding type of grout material to be provided for the associated application. Unless shown or indicated otherwise in the Contract Documents, provide grout in accordance with the following:

TABLE 03600-A, GROUT APPLICATIONS AND MATERIAL TYPES

Application	Required Grout Material Type
Beam and column (one- or two-story height) base plates and precast concrete bearing less than 16 inches in the least dimension	Class II Non-Shrink
Column base plates and precast concrete bearing (greater than two-story height or larger than 16 inches in the least dimension)	Class I Non-Shrink
Base plates for storage tanks and other non-motorized equipment, and motorized equipment or machinery less than 50 horsepower	Class I Non-Shrink (unless otherwise recommended by equipment manufacturer)
Motorized equipment or machinery equal to and greater than 50 horsepower, and motorized equipment or machinery equipment less than 50 horsepower subject to severe shock loads or high vibration	Class III Non-Shrink Epoxy (unless otherwise recommended by equipment manufacturer)
Filling blockout spaces for embedded items such as railing posts, guide frames for hydraulic gates, and similar applications	Class II Non-Shrink (Class I where placement time exceeds 15 minutes)
Grout fill or grout toppings less than four inches thick	Grout Fill
Grout fill greater than four inches thick	Class "B" Concrete in accordance with Section 03300, Cast-In-Place Concrete
Applications not listed above, where grout is indicated on the Drawings	Class I Non-Shrink, unless shown or indicated otherwise

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ACI 211.1, Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
2. ACI 301, Structural Concrete for Buildings.
3. ASTM C33/C33M, Specification for Concrete Aggregates.
4. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
5. ASTM C230/C230M, Specification for Flow Table for Use in Tests of Hydraulic Cement.
6. ASTM C531, Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
7. ASTM C579, Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
8. ASTM C827, Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
9. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
10. ASTM C939, Text Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
11. ASTM C1107/C1107M, Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
12. ASTM C1181, Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
13. NSF/ANSI 61, Drinking Water System Components - Health Effects.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Grout Testing Laboratory:
      a. Independent testing laboratory employed for design and testing of grout materials and mixes shall comply with testing laboratory requirements in Section 03300, Cast-in-Place Concrete and other applicable requirements in the Contract Documents.
   2. Manufacturer: Shall have a minimum of five years experience of producing products substantially similar to that required and shall be able to submit documentation of at least five satisfactory installations that have been in successful operation for at least five years each.
   3. Manufacturer's Field Service Technician: When required, provide services of manufacturer's full-time employee, factory-trained in handling, use, and installing the products required, with at least five years of experience in field applications of the products required.

B. Trial Batch:
   1. Each grout fill and construction joint grout mix proportion and design shall be verified by laboratory trial batch or field experience methods. Comply with ACI 211.1 and submit to Engineer a report with the following data:
      a. Complete identification of aggregate source of supply.
      b. Tests of aggregates for compliance with specified requirements.
      c. Scale weight of each aggregate.
      d. Absorbed water in each aggregate.
      e. Brand, type, and composition of cement.
      f. Brand, type, and amount of each admixture.
      g. Amounts of water used in trial mixes.
      h. Proportions of each material per cubic yard.
      i. Unit weight and yield per cubic yard of trial mixtures.
      j. Measured slump.
      k. Measured air content.

l. Compressive strength developed at seven days and 28 days, from not less than three test specimens cast for each seven-day and 28-day test, and for each design mix.

2. Laboratory Trial Batches: When laboratory trial batches are used to select grout proportions, prepare test specimens and conduct strength tests as specified in ACI 301.

3. Field Experience Method: When field experience methods are used to select grout proportions, establish proportions as specified in ACI 301.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
   a. Schedule of Project-specific grout applications, installation locations, and the grout type proposed for each.
   b. List of grout materials and proportions for the proposed mix designs. Include data sheets, test results, certifications, and mill reports to qualify the materials proposed for use in the mix designs. Do not start laboratory trial batch testing until submittal is approved by Engineer.
   c. Trial Batch Reports: Submit laboratory test reports for grout materials and mix design tests.
2. Product Data:
   a. Data sheets, certifications, and manufacturer's specifications for all materials proposed for use.

B. Informational Submittals: Submit the following:

1. Manufacturer’s Instructions:
   a. Special instructions for shipping, storing, protecting, and handling.
   b. Installation instructions for the materials.
2. Supplier Reports:
   a. Submit written report of results of each visit to Site by Supplier’s field service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
3. Qualifications Statements:
   a. Testing laboratory, when not submitted under other Sections.
   b. Manufacturer, when submittal of qualifications is required by Engineer.
   c. Manufacturer's field service technician, when submittal of qualifications is required by Engineer.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage of Materials: Store grout materials in a dry location, protected from weather and protected from moisture.

PART 2 – PRODUCTS

2.1 GENERAL

A. All grout materials, admixtures, cementitious materials, and other materials used in grout that contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

2.2 NON-SHRINK GROUT MATERIALS

A. General: Non-shrink grout shall be a prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or container in which the materials are packaged. Specific

formulation for each type or class of non-shrink grout specified in this Section shall be that recommended by the grout manufacturer for the particular application.

B. Class I Non-Shrink Grout:
   1. Class I non-shrink grouts shall have a minimum 28-day compressive strength of 7,000 psi. Use grout for precision grouting and where water-tightness and non-shrink reliability in both plastic and hardened states is critical, in accordance with Table 03600-A in this Section.
   2. Products and Manufacturer: Provide one of the following:
      a. Masterflow 928, by Master Builders, Inc.
      b. Five Star Grout, by Five Star Products, Inc.
      c. Hi-Flow Grout, by Euclid Chemical Company.
      d. Or equal.
   3. Comply with ASTM C1107/C1107M, Grade C and B (as modified below) when tested using amount of water required to achieve the following properties:
      a. Fluid consistency (20 to 30 seconds) shall be in accordance with ASTM C939.
      b. At temperatures of 45-, 73.4-, and 95-degrees F.
   4. Length change from placing to time of final set shall not have shrinkage greater than the expansion measured at three or fourteen days. Expansion at three or fourteen days shall not exceed the 28-day expansion.
   5. Non-shrink property shall not be based on chemically-generated gas or gypsum expansion.
   6. Fluid grout shall pass through the flow cone, with continuous flow, one hour after mixing.

C. Class II Non-Shrink Grout:
   1. Class II non-shrink grouts shall have minimum 28-day compressive strength of 7,000 psi. Use grout for general-purpose grouting applications in accordance with Table 03600-A in this Section.
   2. Products and Manufacturer: Provide one of the following:
      a. Construction Grout, by Master Builders, Inc.
      b. FSP Construction Grout, by Five Star Products, Inc.
      c. NS Grout, by Euclid Chemical Company.
      d. Or equal.
   3. Comply with ASTM C1107/C1107M and the following when tested using the quantity of water required to achieve the following properties:
      a. Flowable consistency (140 percent flow in accordance with ASTM C230/C230M, five drops in 30 seconds).
      b. Fluid working time of at least 15 minutes.
      c. Flowable for at least 30 minutes.
   4. When tested, grout shall not bleed at maximum allowed water.
   5. Non-shrink property shall not be based on chemically-generated gas or gypsum expansion.

D. Class III Non-Shrink Epoxy Grout:
   1. Epoxy grout shall be a pourable, non-shrink, 100-percent solids system.
   2. Products and Manufacturer: Provide one of the following:
      a. E3G, by Euclid Chemical Company.
      b. Sikadur 42 Grout Pak, by Sika Corporation.
      c. HP Epoxy Grout, by Five Star Products, Inc.
      d. Or equal.
   3. Epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all pre-measured and prepackaged. Resin component shall not contain non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are unacceptable. Variation of component ratios is not allowed without specific recommendation by manufacturer. Manufacturer's instructions shall be printed on each container in which products are packaged.

4. The following properties shall be attained with the minimum quantity of aggregate allowed by epoxy grout manufacturer.
    a. Vertical volume change at all times before hardening shall be between zero percent shrinkage and 4.0 percent expansion when measured in accordance with ASTM C827 (modified for epoxy grouts by using an indicator ball with specific gravity between 0.9 and 1.1).
    b. Length change after hardening shall be less than 0.0006-inch per inch and coefficient of thermal expansion shall be less than 0.00003-inch per inch per degree F when tested in accordance with ASTM C531.
    c. Compressive creep at one year shall be less than 0.001-inch per inch when tested under a 400-psi constant load at 140 degrees F in accordance with ASTM C1181.
    d. Minimum seven-day compressive strength shall be 14,000 psi when tested in accordance with ASTM C579
    e. Grout shall be capable of maintaining at least a flowable consistency for minimum of 30 minutes at 70 degrees F.
    f. Shear bond strength to portland cement concrete shall be greater than shear strength of concrete when tested in accordance with ASTM C882/C882M.
    g. Minimum effective bearing area shall be 95 percent.

2.3 GROUT MATERIALS OTHER THAN NON-SHRINK GROUT

A. General: Materials for grouts (other than non-shrink grouts) shall be in accordance with Section 03300, Cast-In-Place Concrete, except as otherwise specified in this Section.

B. Grout Fill:
    1. Grout fill shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed in accordance with this Section.
        a. Minimum Compressive Strength: 4,000 psi at 28 days.
        b. Maximum Water-Cement Ratio: 0.45 by weight.
        c. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
        d. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
        e. Air Content: Seven percent (plus or minus one percent).
        f. Minimum Cement Content: 564 pounds per cubic yard.
        g. Slump for grout fill shall be adjusted to match placing and finishing conditions, and shall not exceed four inches.

C. Construction Joint Grout:
    1. Construction joint grout shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned with similar cementitious characteristics as Class “A” concrete specified in Section 03300, Cast-In-Place Concrete. Mix design shall result in grout that is flowable with high mortar content. Mix requirements are:
        a. Minimum Compressive Strength: 4,500 psi at 28 days.
        b. Maximum Water-Cement Ratio: 0.42 by weight.
        c. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
        d. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
        e. Air Content: Seven percent (plus or minus one percent).
        f. Minimum Cement Content: 752 pounds per cubic yard.
        g. Slump for Construction Joint Grout: Seven inches (plus or minute one inch).

2.4 CURING MATERIALS

A. Curing materials shall comply with Section 03300, Cast-in-Place Concrete, and shall be as recommended by the manufacturer of prepackaged grouts.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine substrate and conditions under which grouting will be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Place grout as shown and indicated, and in accordance with Laws and Regulations and grout manufacturer's instructions. If manufacturer's instructions conflict with the Contract Documents, obtain clarification or interpretation from Engineer before proceeding.
   2. Consistency of non-shrink grouts shall be as required to completely fill the space to be grouted for the particular application. Do not install grout for dry-packing without approval of Engineer. When dry-packing is approved by Engineer, dry-pack consistency shall be such that grout has sufficient water to ensure hydration and grout strength development, and remains plastic, moldable, and that does not flow.
   3. Grouting shall comply with temperature and weather limitations in Section 03300, Cast-In-Place Concrete.
   4. Cure grout in accordance with grout manufacturer’s instructions for prepackaged grout and Section 03300, Cast-In-Place Concrete, for grout fill.

B. Columns and Beams:
   1. After shimming columns and beams to proper elevation, securely tighten anchors. Properly form around base plates allowing sufficient room around edges for placing grout. Provide adequate depth between bottom of base plate and top of concrete base to assure that void is completely filled with non-shrink grout.

C. Equipment Bases:
   1. Install equipment in accordance to manufacturer’s recommendations, Laws, and Regulations, and the Contract Documents. After shimming equipment to proper elevation, securely tighten anchors. Properly form around base plates, allowing sufficient room around edges for placing grout. Provide adequate depth between bottom of equipment base and top of concrete base to ensure that voids are completely filled with non-shrink grout.

D. Handrail Posts:
   1. After posts have been properly inserted into holes or sleeves, fill annular space between posts and sleeve with non-shrink grout. Bevel grout at juncture with post so that water will flow away from post.

E. Construction Joints:
   1. Place a six-inch minimum thick layer of construction joint grout over contact surface of concrete at interface of horizontal construction joints in accordance with Section 03251, Concrete Accessories, and Section 03300, Cast-In-Place Concrete.

F. Grout Fill:
   1. All mechanical, electrical, and finish work shall be completed prior to placing grout fill. Base slab shall be provided with a scratched finish in accordance with Section 03300, Cast-

In-Place Concrete. Roughen existing slabs shall by abrasive blasting or hydroblasting exposing aggregates to ensure bonding to base slab.

2. Minimum thickness of grout fill shall be one-inch. Where finished surface of grout fill is to form an intersecting angle of less than 45 degrees with concrete surface against which grout will be placed, form a key in the concrete surface at the intersection point. Key shall be minimum of 3.5 inches wide by 1.5 inches deep.
3. Thoroughly clean and wet base slab prior to placing grout fill. Do not place grout fill until slab is completely free of standing water. A thin coat of neat Type II cement slurry shall be broomed into surface of slab. Place grout fill while slurry is wet. Grout fill shall be compacted by rolling or tamping, brought to elevation, and floated. In tanks and basins where scraping-type equipment will be installed, grout fill shall be screeded by blades attached to revolving mechanism of equipment in accordance with procedures recommended by equipment manufacturer after grout is brought to elevation.
4. Grout fill placed on sloping slabs shall be installed uniformly from bottom of slab to top, for full width of placement.
5. Test grout fill surface with a straight edge to detect high and low spots; immediately correct high and low spots in grout fill. When grout fill has hardened sufficiently, grout fill shall be steel troweled to provide a smooth surface free of bug holes and other imperfections. While an acceptable type of mechanical trowel may be used in this operation, the last pass over the grout fill surface shall be by hand-troweling. During finishing, do not apply the following to the grout fill surface: water, dry cement, or mixture of dry cement and sand.
6. Cure and protect grout fill in accordance with Section 03300, Cast-In-Place Concrete.

3.3 FIELD QUALITY CONTROL

A. Field Testing Services:
   1. Contractor shall employ an independent testing laboratory to perform field quality control testing for grout. Engineer will direct where samples are to be obtained.
   2. Contractor shall provide all curing and necessary cube storage facilities in accordance with ASTM C31.
   3. Comply with testing laboratory requirements in Section 03300, Cast-In-Place Concrete for required testing laboratory qualifications.

B. Quality Control Testing During Construction:
   1. Grout Fill: Perform sampling and testing for field quality control during grout fill placing as follows:
      a. Sampling Fresh Grout Fill: ASTM C172.
      b. Slump: ASTM C143; one test for each load of grout at point of discharge.
      c. Air Content: ASTM C231; one sample for every two grout loads at point of discharge, and when a change in the grout is observed.
      e. Compression Test Specimens:
         1) In accordance with ASTM C109/C109M; make one set of compression cubes for each 50 cubic yards of grout, or fraction thereof, of each mix design placed each day. Each set shall be four standard cubes, unless otherwise directed by Engineer.
   2. Non-shrink Grout: Perform sampling and testing for field quality control during non-shrink grout placing as follows:
      a. Perform compression testing of non-shrink grout in accordance to ASTM C109/C109M at intervals during construction as selected by Engineer. Make a set of four specimens for testing compressive strength at a period of time selected by the Engineer.
      b. Perform compression tests on epoxy grout and fabricate specimens for epoxy grout testing in accordance with ASTM C579, Method B, at intervals during construction as selected by the Engineer. Make a set of four specimens for testing compressive strength at a period of time selected by Engineer.

C. Evaluation of Field Quality Control Tests:
   1. Do not use grout, delivered to final point of placement, having slump or total air content that does not comply with the Contract Documents.
   2. Compressive strength tests for laboratory-cured cubes will be acceptable if averages of all sets of three consecutive compressive strength test results equal or exceed the required 28-day design compressive strength of the associated type of grout.
   3. If the compressive strength tests do not comply with the requirements in the Contract Documents, the grout represented by such tests will be considered defective and shall be removed and replaced, or subject to other action required by Engineer, at Contractor's expense.

D. Manufacturer's Services:
   1. Manufacturers of proprietary materials shall make available upon 72 hours notification the services of qualified, full time employee, experienced in serving as a field service technician for the products required, to aid in assuring proper use of products under the actual conditions at the Site.

+ + END OF SECTION + +

SECTION 03920

AERATION TANK AND Y-WALL CLEANING

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Cleaning includes furnishing all necessary labor, materials and equipment to drain, to clean, to remove, transport and dispose of all settled material and residuals; namely grit, screenings, sludge, rags, stringy material and floatables; from the aeration tanks and y-walls, and to dispose of the residuals in a permitted landfill.

B. Draining and Cleaning
   1. Draining and cleaning shall be performed sequentially in the Aeration Tanks and Y-Walls, as shown and specified and in accordance with the Sequence of Construction.
   2. The existing diffuser grids, diffuser piping and diffusers shall be protected during the cleaning. Any damage to existing diffuser systems shall be repaired at no additional cost. Existing diffusers shall be cleaned prior to placing the tank back in service.
   3. All existing aeration tanks and Y-walls taken offline in sections under this Contract shall be cleaned. The Contractor is advised that significant quantities of material and residuals are settled in the channels. The Contractor shall assume that there is two feet of settled material within the aeration tanks and Y-walls. These materials will be odorous.
   4. Perform cleaning and removal of caked grease at an average depth of one-half (½) inch on the walls and floor of all aeration tanks and Y-walls.
   5. Cleaning shall be performed as often as required to perform Contract work in sequence. As such, a given work area may be cleaned multiple times where multiple channel outages or service interruptions are needed to sequence the work.
   6. The work shall be coordinated with the Engineer.

1.2 PAYMENT

A. All costs for the work of this Section shall be included in the Lump Sum price bid as specified in Division 1 - Measurement and Payment.

1.3 REFERENCES

A. USEPA - United States Environmental Protection Agency

1.4 SAMPLING RESIDUALS

A. The residuals that the Contractor shall remove are not hazardous waste. The residuals consist of grit, screenings, sludge, rags and stringy material and floatables. Grit consists of sand, cinders, small stones, etc. Screenings consist of rags, sticks, etc. Floatables consist of oils, greases, etc.

B. The Contractor shall have an independent laboratory collect and analyze samples of the residuals in the aeration tanks and Y-walls. Unless otherwise specified or required for disposal a minimum of one sample from each tank and Y-wall shall be collected and analyzed for heavy metals, organic compounds, and other selected chemicals typically contained in sludge.

C. The Contractor shall bear all costs associated with collecting and analyzing the samples.

1.5 SAMPLING FOR PERCENT SOLIDS

A. Material and residuals to be transported and disposed of off-site must have a solids concentration higher than 20 percent with no free liquid. If dewatering is required to achieve the minimum solids concentration, the Contractor shall provide appropriate equipment at the job site to test each container of dewatered residuals for percent solids. The Engineer may randomly sample and analyze the dewatered solids.

B. Unless otherwise specified, if the total percent solids of the dewatered residuals is less than 20 percent and/or contains free liquids, the Contractor will not be paid for removal and disposal of such residuals. The Engineer may stop the Contractor's operation until such time as the Contractor can demonstrate that he can raise the percent solids to 20 percent.

C. Should any discrepancies occur between the test results of the Engineer and those of the Contractor, the Contractor shall have his equipment calibrated immediately by an independent company at the Contractor's expense. All percent solids test results shall be logged by the Contractor and made readily available to the Engineer every month or upon request.

1.6 SUBMITTALS

A. The Contractor shall submit the schedule and the means and methods for channel cleaning for the approval of the Engineer in accordance with the requirements of Section 01300 - Submittals. In addition, the submittals shall include, but not be limited to:
   1. Landfill permit(s)
   2. Transportation permits

B. Landfill Permit(s): The Contractor's landfill shall be located within the boundaries of the United States of America. The landfill shall be operated in accordance with all applicable Federal, State and local laws and must be under USEPA and State jurisdiction.
   1. All costs associated with obtaining and maintaining use of the landfill and obtaining necessary permits from the local, State and Federal jurisdictions during the life of the contract shall be borne by the Contractor.
   2. Unless otherwise specified, the following information shall be submitted by the Contractor within 45 consecutive calendar days after the bid opening:
      a. Name, address and location of the landfill. Plant's name, address, telephone, fax number and the contact person at the landfill.
      b. Total acreage and daily capacity of the landfill. Total daily capacity of landfill permitted to specifically accept the Plant's grit, screenings, sludge and floatables under this solicitation.
      c. The USEPA region, State regulatory agency, and the local regulatory agency (if applicable) for which permits are required. Copies of valid, existing operating permits for the landfill from the applicable regulatory agencies.
      d. Copies of valid, existing permits from all applicable regulatory agencies to specifically accept the Plant's grit, screenings, sludge and floatables at the landfill. Permits shall state the maximum capacity of the landfill to accept grit, screenings, sludge and floatables or else the Contractor shall obtain a letter from the applicable regulatory agency verifying the maximum capacity.
      e. A notarized letter from the landfill owner granting permission to bring the Plant's grit, screenings, sludge and floatables to the landfill in the proposed quantities.

C. Transportation Permits: The Contractor shall conduct the transportation of the residuals in accordance with all applicable Federal, State and local laws and regulations. All costs associated with obtaining and maintaining all licenses and permits shall be borne by the Contractor.
   1. The Contractor shall furnish and maintain all licenses and permits during the life of the contract that apply.
   2. For the other states traversed by the transport vehicles, the Contractor shall adhere to all Federal, State and local laws and regulations, and obtain all necessary vehicle and hauling permits.
   3. All transport vehicles shall be operated within the weight limits established in the States and localities through which the transport vehicles must travel.
   4. Unless otherwise specified in the Specifications, the Contractor shall submit, within 45 consecutive calendar days after the bid opening, copies of existing transportation permits.

D. Truck Manifests: The Contractor shall submit, for transporting the residuals, a sample of a truck manifest and container seals.

PART 2 – PRODUCTS

2.1 DRAINING AND CLEANING THE CHANNELS

A. The Contractor shall furnish all the necessary labor, materials and equipment to drain and clean the aeration tanks and Y-walls in sequence.

B. Unless otherwise required by the Specifications, the Contractor shall install a lighting system to fully illuminate the entire work area, including containers, in order that the area can be clearly seen at a distance of at least 100 yards.

C. The Contractor shall not disturb or destroy any equipment or piping in the aeration tanks and Y-walls while cleaning. The Contractor shall be responsible for replacing and restoring any damaged equipment or piping as a result of his operations at his own expense.

D. Upon completion of cleaning, the Contractor shall evenly spray onto each channel a suitable disinfecting deodorant to prevent any foul odors that may linger, and shall restore the work area to the condition prior to the commencement of work.

C. Contractor shall provide all isolating means for isolating the aeration tanks and Y-walls as required to maintain plant operations without interruption. The Contractor shall design, fabricate, furnish, install and remove all equipment required for isolation. The Contractor is responsible for field inspection, measurement and cleaning required for implementationof any new isolating means. The Contractor is responsible for control of all leakage into the work area.

2.2 DEWATERING SETTLED MATERIALS AND RESIDUALS

A. All material and residual dewatering operations, if required, shall occur on the plant grounds at a location approved by the Engineer. The total rate at which the Contractor returns filtrate to the head of the plant shall not be returned to the plant at a rate that has a negative impact on plant process performance.

B. If dewatering residuals is required, the Contractor shall furnish, install and operate a complete mobile dewatering system, including, but not limited to, the following: dewatering equipment, conveyors, sludge feed pumps, piping systems, polymer, polymer mixing and holding tanks, filtrate and service water piping systems, backflow preventers, power cables, lighting, control systems and all accessories and tools for a complete operational system.

C. The manner in which the Contractor returns the filtrate to the head of the plant shall be approved by the Engineer.

D. The Contractor shall furnish and install an inspection valve on the filtrate return line in order that the Engineer may draw samples for analysis.

E. Service water for dewatering or other operations may be available from fire hydrants located at the plant.
   1. The Contractor shall furnish and install an approved backflow preventer between the discharge of the fire hydrant and the Contractor's piping for service water.
   2. In order to ensure an adequate plant water supply, should hydrant pressure drop, water restrictions come into effect, or at the sole discretion of the Engineer, the Contractor shall furnish and install submersible pumps, complete with necessary strainers, piping, fittings, valves, etc., in the final tank effluent water channels and utilize final tank effluent water for his operations.

PART 3 - EXECUTION

3.1 ODOR CONTROL

A. The Contractor shall be responsible for all aspects of odor control for his entire operation including, but not limited to, dewatering, cleaning, storage, transportation and disposal. As such, the Contractor shall take whatever steps are necessary to eliminate all odors which his operation may cause.

B. The Contractor shall furnish and evenly spray onto each filled container X101 Odor Counteractant as manufactured by National Chemical Laboratories (215/922-1200), or approved equal.
   1. The dilution and dosage of X-101 Odor Counteractant shall be as follows: a solution of one part counteractant to 21 parts water shall be prepared by the Contractor and applied to each container at the dosage of 1.25 gallons to 20 cubic yards of residuals.
   2. Depending on the effectiveness of the odor counteractant, the dilution and/or the dosage of the odor counteractant may be increased or decreased at the direction of the Engineer.
   3. The dilution and dosage rate of an odor counteractant submitted as an equal shall be as recommended by the manufacturer and approved by the Engineer.

C. The Contractor shall cover equipment and/or containers as necessary to control odors. Should odor problems persist, even though the Contractor has made every effort to correct it, the Engineer reserves the right to stop the Contractor's operations.

3.2 TRANSPORTATION AND DISPOSAL

A. The Contractor shall furnish all transportation vehicles and equipment necessary for the transportation of the residuals to' a landfill. The Contractor shall pay for all transportation costs, including, but not limited to, maintenance, taxes, fees, tolls, fuel, etc.
   1. A sufficient number of containers and container handling equipment shall be procured by the Contractor in order that the residuals can be managed in a timely manner.
   2. The Contractor shall also have access to backup vehicles and equipment to insure that there is no downtime in connection with operations.

B. Each disposal container shall be constructed of sufficiently heavy gauge metal, have watertight bodies and sealed tailgates equipped with positive locking devices. The Contractor shall control the odor which may emanate from the containers during loading and/or transportation as specified herein.
   1. The Contractor shall furnish and install a metal or tarpaulin cover on each container immediately after the container is full and the odor counteractant has been added. The cover shall be secured in an approved manner and shall remain in place until the container has reached the landfill.
   2. All trucks and containers shall be washed clean of any spills via the Decontamination Station before leaving the plant and shall be maintained in clean, sanitary condition by the Contractor at all times.
   3. The Contractor shall furnish and utilize his own washdown equipment for his cleaning operation.

C. The Contractor shall submit truck routes for approval by the Engineer. The Contractor shall use only Engineer approved truck routes to and from the wastewater treatment plant and the landfill.

D. The Contractor shall provide and maintain a truck manifest and security system. Each load of residuals shall be sealed by the Contractor prior to leaving the wastewater treatment plant. Each seal shall be numbered and the seal number shall be documented on the manifest. A sample manifest and seal shall be submitted to the Engineer for approval prior to the start of work.
   1. Seals must be of such design that they can not be unlocked, removed, reinstalled, relocked or easily cut or broken.
   2. Every month, the Contractor shall submit a copy of the completed manifest for each container to document that the seals were not broken.
   3. The Contractor shall also submit a copy of the landfill weight ticket showing the gross, tare and net weight of each load of residuals.

E. Each landfill weight ticket shall include the truck license plate number, trailer license plate number, container number, time, date, ticket number (to be documented on the manifest) associated manifest number, Contractor's name and transporter's name. The

Contractor shall submit to the Engineer a list of tractors, trailers and containers to be utilized under this contract and their associated tare weights.

3.3 INSPECTION

A. Upon completion of cleaning, each tank and Y-wall will be inspected by the Engineer prior to payment to determine if the channels have been adequately cleaned. The channels shall be considered cleaned when no visible residual material is present.

B. Upon completion of the work at each location, the Contractor shall remove all rubbish and excess materials resulting from his work and shall leave the work location in a condition satisfactory to the Engineer.

+ + END OF SECTION + +

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SECTION 03930

CONCRETE REPAIR AND REHABILITATION

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to repair or rehabilitate, as required, existing concrete shown or indicated in the Contract Documents as being repaired or rehabilitated.
   2. CONTRACTOR shall repair damage to new concrete construction as specified in this Section except for repair Work specified in Section 03300, Cast-in-Place Concrete.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the Work that must be installed with or before repair and rehabilitation of concrete.

C. Related Sections:
   1. Section 03251, Concrete Accessories.
   2. Section 03300, Cast-in-Place Concrete.
   3. Section 03600, Grouting.

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   2. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   3. ASTM D1042, Test Method for Linear Dimensional Changes of Plastics Under Accelerated Service Conditions.
   4. ASTM D3574, Test Methods for Flexible Cellular Materials – Slab, Bonded, and Molded Urethane Foams.
   5. ASTM G109, Test Method for Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments.

1.03 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data: Information on products proposed for use, including manufacturer's brochures, technical data, specifications, and other applicable data.

B. Informational Submittals: Submit the following:
   1. Certificates: Certificates documenting that repair materials that will be in contact with potable water or water that will be treated to become potable are listed in NSF/ANSI 61.
   2. Manufacturer's Instructions: Manufacturer's recommended procedures for installing materials proposed for use.
   3. Site Quality Control Submittals: Results of specified Site quality control testing.
   4. Special Procedure Submittals: When requested by ENGINEER, submit information on methods for supporting during demolition and repair Work existing structures, pipes, and other existing facilities affected by the Work.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling of Materials:
   1. Conform to Section 01610, Transportation and Handling of Materials and Equipment, and this Section.
   2. Clearly mark on containers manufacturer's name and label, name or title of material, manufacturer's stock number, and date of manufacture.
   3. Handle materials carefully to prevent inclusion of foreign matter.
   4. Do not open containers or mix components until necessary preparatory Work has been completed and application Work is to start immediately.

B. Storage of Materials:
   1. Conform to manufacturer's requirements, and this Section.
   2. Store only approved materials at the Site.

PART 2 – PRODUCTS

2.01 SYSTEM REQUIRMENTS

A. Repair and rehabilitation materials that can or will come into contact with potable water or that will be treated to become potable shall be listed in ANSI/NSF 61.

2.02 REPAIR MORTAR

A. Product Description: Repair mortar shall be prepackaged, cement-based product specifically formulated for repairing concrete surface defects and suitable for use in moist and submerged conditions.

B. Products and Manufacturers: Provide one of the following:
   1. Five Star Structural Concrete, by Five Star Products, Inc. Use formulation recommended by manufacturer for the specific application conditions.
   2. SikaTop 122 Plus, SikaTop 123 Plus, SikaTop 111 Plus, or Sikacem 133, by Sika Corporation. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.

3. Emaco S88-CI or S66-CI, by Master Builders Inc. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.
4. DuralTop Gel, DuralTop Flowable Mortar, Verticoat, Verticoat Supreme, or Euco SR-VO, by Euclid Chemical Company. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.

C. Materials:
1. Provide a two-component, polymer-modified, Portland cement, fast-setting, trowel-grade mortar. Repair mortar shall be enhanced with penetrating corrosion inhibitor, and shall have the following properties:

PHYSICAL PROPERTY	VALUE	ASTM STANDARD
MINIMUM COMPRESSIVE STRENGTH AT ONE DAY	2,000 PSI	C109
MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS	6,000 PSI	C109
MINIMUM BOND STRENGTH AT 28 DAYS	1,800 PSI	C882*

* Modified for use with repair mortars.

2. Where the least dimension of the placement in width or thickness exceeds four inches, extend repair mortar by adding aggregate as recommended by repair mortar manufacturer.

2.03 CORROSION INHIBITOR

A. Product Description: Corrosion inhibitor shall penetrate the hardened concrete surface and form a protective layer on reinforcing steel.

B. Products and Manufacturers: Provide one of the following:
1. Sika FerroGard 903, by Sika Corporation.
2. Or equal.

C. Materials:
1. Corrosion inhibitor shall:
a. No change the substrate's color, appearance, or texture.
b. Penetrate independently of orientation (horizontal, vertical, overhead) at rate up to 1/10 to 4/5 inches per day, depending on density of concrete, measured using secondary neutron mass spectroscopy.
c. Form on reinforcing steel a protective layer of high integrity of at least 100 angstroms thickness, measured using x-ray photon spectroscopy and secondary ion mass spectroscopy.
d. Demonstrate reduction in corrosion currents after treatment as determined using cracked beam corrosion tests of concrete, as adapted from ASTM G109.

e. Be capable of reducing active corrosion rates by at least 65 percent. Reduction shall be demonstrated by project references and an independent corrosion engineer using linear polarization resistance.
f. Penetrate up to three inches in 28 days, measured using secondary neutron mass spectroscopy.

2.04 PROTECTIVE SLURRY MORTAR

A. Product Description: Material shall be two-component, polymer-modified, cementitious waterproofing and protective slurry mortar. Provide two coats at coverage of 50 square feet per gallon per coat.

B. Products and Manufacturers: Provide one of the following:
1. Sikatop Seal 107, by Sika Corporation.
2. Or equal.

PART 3 – EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which the repair Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation:
1. Initial Surface Preparation: Remove by chipping, abrasive blasting, or hydro blasting laitance, foreign material, and unsound concrete from entire area to be repaired. Further roughen surface as specified in this Section. Where non-shrink grout or repair mortar is used, perform additional surface preparation, if any, recommended by product manufacturer.
2. Wetting Procedure: Where repair concrete, shotcrete, or cement grout is used, and bonding agent is not required, or where repair mortar or non-shrink grout manufacturer recommends wet or saturated surface, perform the following:
a. Continuously apply water for at least four hours to surface being repaired. Where large surface areas are to be repaired, use fog-spray nozzles, mounted on stands, in sufficient number so that entire surface to be repaired is contacted by fog spray cloud.
b. Prevent concrete from drying until after repair is completed. Re-wet surfaces not yet repaired using water sprays at least a daily; should more than four days elapse without re-wetting surfaces not yet repaired, repeat the original saturating procedure.
c. Remove standing water in areas to be repaired before placing repair material. Provide means to remove excess water from structure.

3.03 INSTALLATION, GENERAL

A. Construction Tolerances: Shall be as specified in Section 03300, Cast-in-Place Concrete, except as specified in this Section and elsewhere in the Contract Documents.

B. Care shall be taken to fully consolidate repair material, completely filling portions of space to be filled.

C. Bring surface being repaired into alignment with adjacent surfaces, providing uniform, even surface. Surface repaired shall match adjacent existing surfaces in texture and shall receive coatings or surface treatments, if any, provided for the existing surface adjacent to repaired surface.

D. Curing:
   1. Curing of repair mortar and non-shrink grout shall be in accordance with manufacturer's recommendations, except that minimum cure period shall be three days.
   2. Curing of other materials shall be in accordance with requirements of Section 03300, Cast-in-Place Concrete.

3.04 REPAIR OF SURFACE DEFECTS

A. Surface defects are depressions in a concrete surface that do not extend the way through the concrete. Surface defects can result from removal of an embedded item, removal of an intersecting concrete member, physical damage, or unrepaired rock pockets created during original placement. For spalls that result from corroded reinforcing steel or other embedment refer to relevant Articles of this Section.

B. Preparation: Perform the following in addition to requirements as indicated in this Section:
   1. Remove by chipping loose, damaged concrete to sound material.
   2. Where existing reinforcing is exposed, remove concrete to minimum of one-inch around exposed bars. If existing bars are cut through, cracked, or cross sectional area is reduced by more than 25 percent from original, immediately notify ENGINEER.
   3. Score-cut perimeter of area to be repaired to minimum depth of 1/2-inch and maximum depth that will not cut existing reinforcing steel. Chip out existing concrete to the score line so that minimum thickness of repair mortar will be 1/2-inch.

C. Repair Material:
   1. Completely fill the surface defect with specified repair material, in accordance with material manufacturer's instructions and the Contract Documents.
   2. Perform, with repair mortar, repairs of surface defects in concrete normally in contact with water or soil, and interior surfaces of structures that contain water.
   3. Repair of other surface defects may be by applying repair mortar, repair concrete, shotcrete, or cement grout, as appropriate.

3.05 PATCHING OF HOLES IN CONCRETE

A. Fill openings less than four inches in their least dimension with Class III non-shrink epoxy grout in accordance with Section 03600, Grouting.

B. Openings greater than four inches and less than 16 inches in their least dimension shall be coated with an epoxy bonding agent prior to filling with Class I non-shrink grout in accordance with Section 03600, Grouting.

C. Openings greater than 16 inches in their least dimension shall be coated with an epoxy bonding agent prior to filling with Class A concrete in accordance with Section 03300, Cast-in-Place Concrete.

D. Where repaired holes are in contact with water or soil, provide hydrophilic rubber waterstop within the opening in accordance with Section 03251, Concrete Accessories, prior to filling with repair material.

3.06 REPAIR OF DETERIORATED CONCRETE

A. This Article pertains to deteriorated concrete which has been damaged due to corrosion of reinforcing steel, physical damage due to abrasion, or damage due to chemical attack. Use repair mortar, as specified in this Article, for repairing deteriorated concrete. Where repaired surface will be subsequently covered with plastic liner material, coordinate finishing with requirements for installing plastic liner material.

B. Surface Preparation: In addition to requirements indicated elsewhere in this Section, perform the following surface preparation:
   1. Remove loose, broken, softened, and acid-contaminated concrete by abrasive blasting and chipping to sound, uncontaminated concrete.
   2. Upon completion of removal of deteriorated concrete, notify ENGINEER in writing. Allow two weeks for ENGINEER to evaluate the surface, perform testing for acid contamination if required, determine if additional concrete shall be removed, and to develop special repair details (if any) required. Should ENGINEER determine that additional concrete be removed to reach sound, uncontaminated concrete, allow another two-week period for further evaluation and testing following the additional removal.
   3. Surface preparation shall conform to recommendations of repair mortar manufacturer.
   4. Repair and rehabilitate isolated areas of exposed reinforcing bars in accordance with this Section. If extensive areas of reinforcing steel are uncovered after removal of deteriorated concrete, ENGINEER will determine the repair methods required.

C. Repair Mortar Placing:
   1. Conform to manufacturer's recommended procedures for mixing and placing repair mortar.
   2. After initial mixing of repair mortar, addition of water is not allowed.

3. Minimum Thickness:
    a. Install repair mortar to not less than minimum thickness recommended by manufacturer, and not less than 1/2-inch.
    b. Where removal of deteriorated concrete results in repair thickness of less than minimum required thickness to return to original concrete surface in isolated areas totaling less than ten percent of total repair surface area, remove additional concrete to obtain at least the required minimum thickness.
    c. Where surface area with repair thickness less than minimum required thickness exceeds ten percent of total repair area, notify ENGINEER.
    d. Provide repair mortar so that minimum cover over existing reinforcing steel is two inches. Do not place repair mortar creating locally raised areas.
    e. Where transitioning to or from wall surfaces not requiring repair, do not feather-out repair mortar at transition. Instead, form the transition by saw cutting a score line to not less than minimum required repair mortar depth and chip out concrete to the saw cut line. Do not cut or otherwise damage reinforcing steel.
4. Place repair mortar to an even, uniform plane to restore concrete member to its original surface. Out-of-plane tolerance shall be such that the gap between 12-inch long straight edge and repair mortar surface does not exceed 1/8-inch, and gap between a four-foot long straight edge and repair mortar surface shall not exceed 1/4-inch. Tolerances specified in this paragraph apply to straight edges placed in orientation at location.

D. Finishing:
1. Provide smooth, steel trowel finish to repair mortar.
2. When completed, there shall be no sharp edges. Provide exterior corners, such as at penetrations, one-inch radius. Interior corners shall be square, except corners to receive plastic lining which shall be made with two-inch fillet in repair mortar.

3.07 REPAIR OF EXPOSED REINFORCING

A. Remove, by abrasive blasting or hydro blasting, corrosion, foreign materials, and unsound concrete from area to be repaired.

B. For mortar coating, conform to other paragraphs of this Section.

3.08 PROTECTIVE SLURRY MORTAR COATING

A. Remove, by abrasive blasting or hydro blasting, corrosion, foreign materials, and unsound concrete from area to be repaired.

B. Surface shall be visually dry before applying corrosion inhibitor. Liberally apply corrosion inhibitor to achieve coverage of 100 square feet per gallon in two or more coats, by allowing corrosion inhibitor to soak into substrate. Time between coats shall be the longer of: one hour, or as recommended by corrosion inhibitor manufacturer. Apply using rollers, brushes, or hand-pressure spray equipment.

C. After applying final coat of corrosion inhibitor, minimum cure time of 24 hours is required.

D. Provide high-pressure wash to surfaces to be repaired to remove filmy residue from corrosion inhibitor.

E. Apply protective slurry mortar per manufacturer recommendations.

3.09 SITE QUALITY CONTROL

A. OWNER will employ and pay for services of testing laboratory for Site quality control testing. ENGINEER will direct the number of tests and specimens required. CONTRACTOR shall make standard compression test specimens as specified in this Section under the observation of ENGINEER. CONTRACTOR shall provide:
   1. Necessary assistance required by ENGINEER.
   2. All labor, material, and equipment required, including rods, molds, thermometer, curing in heated storage box, and other incidentals required, subject to approval by ENGINEER.
   3. All necessary storage, curing, and transportation required for testing.
   4. CONTRACTOR will be charged for cost of additional testing and investigation, if any, for Work performed that is not in accordance with the Contract Documents or is otherwise defective.

B. Site Tests of Cement-based Grouts and Repair Mortar:
   1. Obtain compression test specimens during construction from first placement of each type of mortar or grout, and at intervals thereafter as selected by ENGINEER, to verify compliance with the Contract Documents.
   2. Compression tests and fabrication of specimens for repair mortar and non-shrink grout will be performed in accordance with ASTM C109. Set of three specimens will be made for each test. Tests will be made at seven days, 28 days, and additional time periods as deemed appropriate by ENGINEER.
   3. Material, already placed, failing to conform to the Contract Documents, is defective.

C. Repair Concrete: Repair concrete shall be tested as required in Section 03300, Cast-in-Place Concrete.

+ + END OF SECTION + +

SECTION 04060

MASONRY MORTARING AND GROUTING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install masonry mortaring and grouting for unit masonry construction.
   2. This Section includes masonry mortaring and grouting for masonry products specified in:
      a. Section 04211, Brick Masonry.
      b. Section 04220, Concrete Unit Masonry.
   3. Types of materials required under this Section include:
      a. Portland cement-lime mortars.
      b. Fire-resistant mortars.
      c. Ready-mixed mortar
      d. Fine grout.
      e. Coarse grout.
      f. Grout fill around reinforcement in masonry lintels and bond beams.

B. Related Sections:
   1. Section 04201, Unit Masonry Construction.
   2. Section 04211, Brick Masonry.
   3. Section 04220, Concrete Unit Masonry.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/UL 263, Fire Resistance Ratings.
      a. BXUV U901, Bearing Wall Rating – 4 HR.; Nonbearing Wall Rating – 4 HR.
      b. BXUV U902, Bearing Wall Rating – 4 HR., Alternative Detail.
      c. BXUV U904, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR.
      d. BXUV U905, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR.
      e. BXUV U906, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR.
      f. BXUV U907, Nonbearing Wall Rating – 3 or 4 HR.
      g. BXUV U909, Nonbearing Wall Rating – 3 or 4 HR.

h. BXUV U910, Bearing Wall Rating – 4 HR.; Nonbearing Wall Rating – 4 HR.
i. BXUV U912, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR.
j. BXUV U913, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR.
k. BXUV U914, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR.

3. ASTM C5, Specification for Quicklime for Structural Purposes.
4. ASTM C144, Specification for Aggregate for Masonry Mortar.
5. ASTM C150/C150M, Specification for Portland Cement.
6. ASTM C207, Specification for Hydrated Lime for Masonry Purposes.
7. ASTM C270, Specification for Mortar for Unit Masonry.
8. ASTM C387/C387M, Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
9. ASTM C404, Specification for Aggregates for Masonry Grout.
10. ASTM C1019, Test Method for Sampling and Testing Grout.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
1. Do not change source or brands of mortar materials during the Project.

B. Regulatory Requirements:
1. Where fire-resistance classification is shown or indicated for unit masonry construction (four-hour, three-hour, and similar designations), proportion mortar and masonry grouts to comply with requirements established by fire rating designations of ANSI/UL 263 indicated in this Section, Laws and Regulations, and requirements of authorities having jurisdiction.

C. Job Mockup: Refer to Section 04201, Unit Masonry Construction.

D. Pre-submittal Meeting:
1. Before submitting Samples of colored mortar for approval, Contractor and Supplier shall meet at the Site with Engineer to review existing mortar to be matched and to preview proposed materials and colors.
2. Refer to Section 04201, Unit Masonry Construction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Schedule of locations where each mortar type will be used in the Work.
b. Grout mix design and material certification.
2. Product Data:

a. Manufacturer's specifications and instructions for each manufactured material or product.
b. Compression test results of grout mix, for identical mix previously prepared and tested, in accordance with ASTM C1019, at maximum aggregate allowed. If no previously-prepared mix is identical, perform tests on the job mix design in accordance with ASTM C1019 and submit to Engineer.
c. Product data and specifications for integral waterproofing admixture.

3. Samples:
   a. Each type of colored mortar, showing range of color expected in the Work.
   b. Label samples to indicate type and quantity of colorant used.
   c. Engineer's review will be for color only. Compliance with other requirements is Contractor's responsibility.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Portland Cement: Provide the following for portland cement-lime mortars:
   1. ASTM C150/C150M:
      a. Use Type I when installation temperature is 50 degrees F or higher.
      b. Use Type III, high-early strength, when installation temperature is lower than 50 degrees F.
   2. Products and Manufacturers: Provide one of the following:
      a. Type I and Type III Portland Cement, by Essroc Italcementi Group.
      b. Type I and Type III Portland Cement, by Lehigh Portland Cement Company.
      c. Or equal.
   3. Provide non-staining portland cement of natural color or of color required to be compatible with required mortar pigment color selected by Engineer.

B. Hydrated Lime: ASTM C207, Type S, or lime putty ASTM C5.

C. Sand Aggregates:
   1. Mortar Aggregates: ASTM C144, except for joints less than 1/4-inch use aggregate graded with 100 percent passing the No. 16 sieve.
   3. Colored Mortar Aggregates: Provide ground marble, granite or other sound stone, as required to match the Sample approved by Engineer for portland cement-lime mortars.
   4. Fine Aggregate for Grout: ASTM C404, Size No. 1.
   5. Coarse Aggregate for Grout: ASTM C404, Size No. 8 or Size No. 89.

D. Colored Mortar Pigments: Provide the following for portland cement-lime mortars:

1. Commercial iron oxide, manganese dioxide, ultramarine blue, chromium oxide, or carbon black, compounded for use in mortar mixes.
2. Products and Manufacturers: Provide one of the following:
    a. True-Tone Mortar Colors, by Davis Colors, a Subsidiary of Rockwood Pigments, Inc.
    b. SGS Concentrated Mortar Colors, by Solomon Colors.
    c. Or equal.
3. Do not exceed pigment to cement ratios, by weight, of one-to-35 for carbon black, and one-to-seven for other pigments.
4. Submit complete selection of manufacturer's standard and custom colors for final selection by Engineer.

E. Ready-mixed Mortar: Cementitious materials, water, and aggregate complying with requirements specified in Article 2.1 of this Section, combined with set-controlling admixtures to produce a ready-mixed mortar complying with ASTM C270 and ASTM C387/C387M.

F. Water: Free of injurious amounts of oils, acids, alkalis, and organic matter, and clean, fresh, and potable.

G. Water-repellent Admixture for Exterior Masonry Mortar:
1. Provide cross-linked acrylic polymer integral waterproofing system.
2. Products and Manufacturers: Provide one of the following:
    a. DRY-BLOCK Mortar Admixture, by Grace Construction Products Division, W. R. Grace & Company.
    b. Eucon Blocktite Mortar Admixture, by Euclid Chemical Company.
    c. Or equal.
3. Proportion: In accordance with manufacturer's instructions.

2.2 MORTAR MIXES

A. General:
1. Material Performance:
    a. Masonry Strength: Refer to Section 04201, Unit Masonry Construction.
    b. If questions of compliance with the Contract Documents arise, Specifications for mortar properties shall take precedence over Specification for mortar proportions.
2. Do not change proportions established for mortar approved, and do not use materials with different physical characteristics in mortar used in the Work, unless compliance with the Contract Documents for mortar properties is re-established via submittals approved by Engineer.
4. Do not combine in mortar different air-entraining materials.
5. Anti-freeze Admixture or Agents: Not allowed.
6. Calcium Chloride: Not allowed.

B. Fire-Resistant Mortar:
   1. Reference Standard: ANSI/UL BXUV U901 through BXUV U914.
   2. Proportion: Use one part portland cement, three parts clean sand, and 15 percent hydrated lime (by cement volume).

C. Mortar for All Other Unit Masonry: Comply with ASTM C270, Table 2, except limit materials to those specified in this Section. Limit cement-to-lime ratio by volume as follows:
   1. Type S:
      a. Provide the following proportions by volume:
         1) Portland Cement: One part.
         2) Hydrated Lime or Lime Putty: Over 1/4 to 1/2, maximum.
         3) Aggregate Ratio (measured in damp loose condition): Not less than 2-1/4 and not more than three times sum of volumes of cementitious materials.
      b. Properties:
         1) Average Compressive Strength, ASTM C270: 1,800 psi.
         2) Minimum Water Retention, ASTM C270: 75 percent.
         3). Maximum Air Content, ASTM C270: 12 percent.
   2. Type N:
      a. Provide the following proportions by volume:
         1) Portland Cement: One part.
         2) Hydrated Lime or Lime Putty: Over 1/2 to 1-1/4, maximum.
         3) Aggregate Ratio (measured in damp loose condition): Not less than 2-1/4 and not more than three times sum of volumes of cementitious materials.
      b. Properties:
         1) Average Compressive Strength, ASTM C270: 750 psi.
         2) Minimum Water Retention, ASTM C270: 75 percent.
         3) Maximum Air Content, ASTM C270: 12 percent.

D. Grout:
   1. Fine Grout:
      a. Provide the following proportions by volume:
         1) Portland Cement: One part.
         2) Hydrated Lime or Lime Putty: Zero to 1/10 part.
         3) Aggregate Ratio (measured in a damp loose condition): Sand; not less than 2-1/4 and not more than three times sum of volumes of cementitious materials.
      b. Mix grout to have slump of ten inches plus or minus one inch at time of placement.
   2. Coarse Grout:
      a. Provide the following proportions by volume:
         1) Portland Cement: One part.
         2) Hydrated Lime or Lime Putty: Zero to 1/10 part.

3) Fine Aggregate Ratio (measured in a damp loose condition): Sand; not less than 2-1/4 and not more than three times sum of volumes of cementitious materials.
4) Coarse Aggregate Ratio: Not less than one and not more than two times the sum of volumes of cementitious materials.

b. Mix grout to have slump of ten inches plus or minus one inch at time of placement.

E Grout Fill Around Reinforcement in Masonry Lintels: Portland cement, sand, gravel and water, to be proportioned as required to provide 28-day minimum compressive strength of 2,000 psi.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be performed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Measurement of Materials:
1. Cement and Hydrated Lime: Batched by the bag.
2. Sand: Batched by volume in suitably calibrated containers. Make allowance for bulking and consolidation, and for weight per cubic foot of contained moisture.
3. Proportion of Volumetric Mixtures: One 94-pound sack of portland cement and one 50-pound sack of hydrated lime constitute nominal one cubic foot.
4. Shovel measurement: Unacceptable.

B. Mortar Mixing:
1. Type of Mixer: Machine mix in appropriate mixer in which quantity of water is accurately and uniformly controlled.
2. While mixer is operating, add approximately three-quarters of required water, half the sand, all the cement, and then add remainder of sand.
3. Allow batch to mix briefly and then add balance of water in small quantities until satisfactory workability is obtained.
4. Mix for not less than five minutes after all materials have been added.
5. Hydrated Lime for Mortar Requiring Lime Content: Use dry-mix method. Turn materials over together for each batch until even color of mixed, dry materials indicates that cementitious material has been thoroughly distributed throughout the mass, and then add water to obtain required plasticity.

6. Prepare lime putty, if approved for use, in accordance with ASTM C5.
7. Waterproofing Admixture: Add to mortar mix for all exterior masonry in accordance with manufacturer's instructions.
8. Mixer drum shall be completely emptied before recharging the next batch.
9. Limit batch size to avoid re-tempering. Re-tempering of mortar is not allowed.

3.3 INSTALLATION AND MORTAR AND GROUT TYPE LOCATION

A. For mortar and grout type, location, and installation requirements, refer to:
   1. Section 04201, Unit Masonry Construction.

3.4 FIELD QUALITY CONTROL

A. Site Tests:
   1. Refer to Section 04201, Unit Masonry Construction, for load-bearing masonry wall strength tests.

+ + END OF SECTION + +

+ + NO TEXT ON THIS PAGE + +

SECTION 04090

MASONRY ANCHORAGE AND REINFORCING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install masonry anchorages and reinforcing.
   2. Section specifies masonry anchorages and reinforcing for Work specified in:
      a. Section 04201, Unit Masonry Construction.
   3. Types of products required include:
      a. Continuous horizontal wire reinforcing and ties.
      b. Individual wire ties.
      c. Anchoring and positioning devices.
      d. Miscellaneous masonry accessories, reinforcing bars, compressible filler, and premolded control joint strips.

B. Coordination:
   1. Provide masonry anchorages and reinforcing of sizes, dimensions and configurations coordinated with unit masonry construction system component sizes, dimensions and configurations.
   2. Where continuous horizontal cavity wall reinforcement is required for restraining cavity wall insulation, coordinate dimensions with specified thickness of cavity wall insulation for proper clearances. Refer to Section 07210, Building Insulation.

C. Related Sections:
   1. Section 04201, Unit Masonry Construction.
   2. Section 05120, Structural Steel Framing.
   3. Section 07210, Building Insulation.
   4. Section 07620, Sheet Metal Flashing and Trim.
   5. Section 07920, Joint Sealants.
   6. Section 09900, Painting.

1.2 REFERENCES

A. Reference Standards: Standards referenced in this Section are:
   1. ACI 315, Details and Detailing of Concrete Reinforcement.
   2. ASTM A36/A36M, Specification for Carbon Structural Steel.
   3. ASTM A82/A82M, Specification for Steel Wire, Plain, for Concrete Reinforcement.

4. ASTM A153/A153M, Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
5. ASTM A240/A240M, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
6. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
7. ASTM A663/A663M, Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
8. ASTM A1008/A1008M, Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
9. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
10. ASTM D2240, Test Method for Rubber Property – Durometer Hardness.
11. ASTM D2287, Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
12. UL U901, Bearing Wall Rating – 4 HR.; Nonbearing Wall Rating – 4 HR (ANSI/UL 263).
13. UL U902, Bearing Wall Rating – 4 HR., Alternative Detail (ANSI/UL 263).
14. UL U904, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR (ANSI/UL 263).
15. UL U905, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR (ANSI/UL 263).
16. UL U906, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR (ANSI/UL 263).
17. UL U907, Nonbearing Wall Rating – 3 or 4 HR (ANSI/UL 263).
18. UL U909, Nonbearing Wall Rating – 3 or 4 HR (ANSI/UL 263).
19. UL U910, Bearing Wall Rating – 4 HR.; Nonbearing Wall Rating – 4 HR (ANSI/UL 263).
20. UL U912, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR (ANSI/UL 263).
21. UL U913, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR (ANSI/UL 263).
22. UL U914, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR (ANSI/UL 263).

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Provide all metal sheet, wire, plate and bar stock masonry anchorages and reinforcing from same manufacturer.

2. Miscellaneous masonry accessory items other than metal sheet, wire, plate and bar stock shall each be obtained from a single, manufacturer, which may be different from the manufacturer of other products specified in this Section.

B. Regulatory Requirements:
   1. Where fire-resistance classification (four-hour, three-hour, and similar designations) is shown or indicated for unit masonry construction, provide masonry anchorages and reinforcing complying with requirements established by UL tests referenced in this Section (UL U901 through UL U914, as applicable), Laws and Regulations, and requirements of authorities having jurisdiction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit drawings and material schedules showing all dimensions and sizes of masonry anchorages and reinforcing coordinated with unit masonry Work and other Work in which masonry anchorages and reinforcing will be embedded, be supported from, or restrained.
      b. Submit schedule indicating type, location, and spacing of each masonry accessory in unit masonry construction and that type, location, and spacing are in compliance with code requirements.
   2. Product Data:
      a. Manufacturer’s product literature and specifications for each masonry accessory required. Include data substantiating that materials comply with the Contract Documents.
   3. Samples:
      a. One unit or one modular length of each item specified.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. Manufacturer’s instructions for handling, storing, and installing for each masonry accessory required.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with:
   1. Applicable requirements of standards referenced in this Section.
   2. Section 01610, Transportation and Handling of Materials and Equipment.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Continuous Horizontal Wire Reinforcing and Ties: Provide the following for all masonry walls unless otherwise shown or indicated:
   1. General: Provide the following:
      a. Reinforcement, wire and ties of cold-drawn steel wire complying with ASTM A82 and hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153 .
      b. Welded wire units, prefabricated in straight lengths, at least ten feet long, with matching corner "L" and intersection "T" units, all with deformed continuous nine-gage side rods and plain nine-gage truss-type diagonal cross-rods, butt-welded to side rods, not more than 16 inches on centers, with unit width of 1.5 to two inches less than thickness of wall or partition.
      c. Rectangular boxes, pintles and ties fabricated of 3/16-inch diameter wire, unless otherwise specified.
   2. Single-wythe and Multi-wythe Masonry Walls (except cavity wall):
      a. Wall reinforcement system with one horizontal rod beneath each unit masonry face shell wall.
      b. Products and Manufacturers: Provide products of one of the following:
         1) Truss Mesh Reinforcement with #120 Truss-Mesh by Hohmann & Barnard, Inc.
         2) #DA 3100 Truss by Dur-O-Wal, Division of Dayton Superior.
         3) Or equal.
   3. Multi-wythe Masonry Cavity Walls:
      a. Tab-type wall reinforcing and support system with single pair of side rods in interior wythe, four-inch wide boxes with restraint bar welded across box and adjustable rectangular pintle ties spaced not more than 16 inches on centers. Space side rods for embedment in each face shell wall of back-up wythe and extend box to allow engagement of rectangular pintle box tie for proper embedment in facing wythe.
      b. Products and Manufacturers: Provide one of the following:
         1) #165 Truss, by Hohmann & Barnard, Inc.
         2) DA 3300 - Adjustable Dur-O-Tab with Restraint Bar, by Dur-O-Wal, Division of Dayton Superior.
         3) Or equal.
   4. Provide special, custom-fabricated shapes to accommodate curved cavity, multi-wythe and single-wythe wall construction.

B. Individual Wire Ties for Masonry: Provide the following where shown:
   1. General: Provide the following:
      a. Reinforcing, wire, and ties of Cold-drawn steel wire complying with ASTM A82 and hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153.

b. Crimped with vee-drip for use in cavity wall construction and of length required for proper embedment in outer-most face shell walls of wythes of masonry shown or indicated.
c. Rectangular box ties and adjustable box ties fabricated of 3/16-inch diameter wire.

2. Single-piece Ties (where facing and back-up joints align):
a. For use with hollow masonry units laid with cells vertical and with solid masonry units or hollow units laid with cells horizontal, provide four-inch wide rectangular shaped box-ties.
b. Products and Manufacturers: Provide one of the following:
1) Rectangular Box Ties, by Hohmann & Barnard, Inc.
2) No. 253 Rectangular Wire Ties, by Heckmann Building Products.
3) Or equal.

C. Anchoring Devices for Masonry: Provide the following, unless otherwise shown or indicated:
1. General: Provide the following:
a. Cold-rolled steel sheet complying with ASTM A1008; hot-rolled steel sheet and strip complying with ASTM A1011; plates and bars complying with ASTM A36; and cold-drawn steel wire complying with ASTM A82 all hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153
b. Rectangular, corrugated, one-inch wide ties, fabricated of 12-gage sheet metal, unless otherwise specified.
c. Size tie lengths to extend to within one-inch of outside face of outer wythe face shell of opposite face of masonry or to a maximum depth of 12 inches and between 1.5 to two inches less than width of masonry abutting webs and to maximum depth of 12 inches abutting flanges of structural supports. Provide wire crimped with a vee-drip for use in cavity wall construction.
d. Flexible Anchors: Where masonry abuts structural walls or framework, provide flexible anchors that allow horizontal and vertical movement of masonry, but provides lateral restraint.

2. Anchorage to Cast-in-Place Concrete Walls, Columns and Spandrels: Provide the following for lateral restraint of unit masonry walls abutting cast-in-place concrete members:
a. Two-piece anchors with 14-gage dovetail head and 3/16 inch diameter by 7 inch long flexible dovetail brick tie, as shown.
b. Products and Manufacturers: Provide one of the following:
1) #315 - Flexible Dovetail Brick Tie and #305 - Dovetail Slot, by Hohmann & Barnard, Inc.
2) No. 103 - Dovetail Triangular Tie and No. 100 - Standard Anchor Slot, by Heckmann Building Products.
3) Or equal.

3. Anchorage to Steel Columns and Steel Beam Webs: Provide the following for lateral restraint of unit masonry walls at structural steel framework:

a. U-shaped, 7.5-inch long channels welded to steel structure, with 5.5 inches of vertical adjustment, fabricated from 11-gage steel with slotted ties.
b. Products and Manufacturers: Provide one of the following:
1) #360 - Gripstay Channels and #364 - Corrugated Gripstay Anchor, by Hohmann & Barnard, Inc.
2) No. 130 Channel Anchor Slots and No. 134 Corrugated Anchor, by Heckmann Building Products.
3) Or equal.

4. Anchorage to Bottom of Concrete Beams and Slabs and Bottom of Steel Beam Flanges: Provide the following for lateral restraint of unit masonry walls at bottom of beam flanges and concrete slabs:
a. Fabricated steel bend plate, refer to drawings for additional information.
5. Lateral Supporting Masonry Wall Anchors: Provide the following for bracing freestanding walls exceeding allowable unbraced span:
a. Products and Manufacturers: Provide one of the following:
1) #344 Rigid Partition Anchor, by Hohmann & Barnard, Inc.
2) #140 Masonry Anchor, by Heckmann Building Products.
3) Or equal.
b. Plate, 1/4-inch thick by two inches wide fabricated with two-inch long bent legs at 90 degrees to flat face of anchor and of length to extend to center of each wythe of wall, but not less than 2.33 feet long. Cut to length as required.
6. Rebar Positioners: Provide the following:
a. Products and Manufacturers: Provide one of the following:
1) #RB Series and #RB-Twin Series Rebar Positioners, by Hohmann & Barnard, Inc.
2) Rebar Positioners, by Heckmann Building Products.
3) Or equal.
b. Nine-gage reinforcing bar positioners that accommodate both horizontal and vertical reinforcing steel.
c. Fabricate units as required for the Work.

D. Miscellaneous Masonry Accessories: Provide the following where shown:
1. Reinforcing Bars:
a. Deformed carbon steel, ASTM A615, Grade 60 for bars No. 3 to No. 18, except as otherwise shown.
b. Plain carbon steel, ASTM A663, Grade 80 where No. 2 bars are shown or required.
c. Provide galvanized steel reinforcing bars complying with ASTM A153, Class B-1, where shown.
2. Compressible Filler: Provide watertight joint filler where unit masonry construction abuts structural framework members, or as shown. Provide the following:

a. Products and Manufacturers: Provide one of the following:
   1) Polytite Standard, by Polytite Manufacturing Corp.
   2) Polyseal, by Sandell Manufacturing Company, Inc.
   3) Or equal.
b. Polyurethane foam strip saturated with polybutylene waterproofing material that, when installed at a compression ratio of two-to-one, is impermeable to water.
c. Resilient to -40 degrees F with 100 percent movement recovery.
d. Elongation of 140 percent with a tensile strength of not less than 53 pounds per square inch.

3. Masonry Control Joint Components: Provide the following:
   a. Premolded Control Joint Strips: Provide complete selection of solid extruded rubber and PVC strips with a Shore A durometer hardness of 80 to 90 complying with ASTM D2240 and ASTM D2287, designed to fit standard sash block and maintain lateral stability in masonry wall. Size and configuration shall be as shown.
      1) Products and Manufacturers: Provide one of the following:
         a) #RS-12 - Control Joints, by Hohmann & Barnard, Inc.
         b) 352-12 Control Joints, by Heckmann Building Products.
         c) Or equal.
   b. Sealants: Refer to Section 07920, Joint Sealants.
4. Weep Holes: Provide the following:
   a. Products and Manufacturers: Provide one of the following:
      1) #342 - Plastic Weep Holes, by Hohmann & Barnard, Inc.
      2) No. 330 Plastic Weepholes, by Heckmann Building Products.
      3) Or equal.
   b. Rectangular 3/8-inch wide by 1.5 inches high, 3.5 inches long clear butyrate tubes.
4. Weep Vents: Provide the following:
   a. Products and Manufacturers: Provide one the following:
      1) Goodco Brick Vents, by Williams Products, Inc.
      2) No. 602 Louvered Weep Holes and Vents, by WIRE-BOND.
      3) Or equal.
   b. Provide injection molded flexible polyvinylchloride brick vents of custom color to match face brick mortar color with top flap, flexible side wings, vertical louvers and water ridges.
5. Cavity Fill Mesh: Provide the following:
   a. Products and Manufacturers: Provide one of the following:
      1) #MGS - Mortar/Grout Screen, by Hohmann & Barnard, Inc.
      2) No. 267 Plastic Mesh Wall Ties, by Heckmann Building Products.
      3) Or equal.
   b. Monofilament screen of polypropylene polymers 1/4-inch mesh hardware cloth. Provide below all block courses that are to be filled with mortar.
6. Cavity Drainage Material:

a. Manufactured of high density polyethelene or nylon strands woven into a 90 percent open mesh
   1) Product and Manufacturer: Provide one of the following:
      a) Mortar Net, by Hohmann and Barnard, Inc.
      b) Mortar Net, by Heckmann Building Products.
      c) Or equal.

7. Imbedded Flashing Materials:
   a. Metal Flashing: Refer to Section 07620, Sheet Metal Flashing and Trim.

2.2 FABRICATION

A. Weld-in-place all channel slots and other specified weld-on anchors at the shop. Field welding is unacceptable.

B. Coordinate location of weld-on anchors and show on structural steel Shop Drawings required under Section 05120, Structural Steel Framing.

C. Weld anchor slots and other required accessories in place before shop priming of structural steel.

D. Prime coat weld-on anchors and other accessories and passivate anchor coating in accordance with Section 09900, Painting.

E. Shop-fabricate reinforcing bars that are shown or required to be bent or hooked. Comply with ACI 315 for fabricating reinforcing steel for unit masonry Work.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Refer to the following:
   1. Section 04201, Unit Masonry Construction.

+ + END OF SECTION +

SECTION 04100

MORTAR

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work covered by this Section includes the furnishing and application of mortar for masonry work.

B. Related work specified elsewhere includes: Div. 3 – Concrete.

1.2 SUBMITTALS

A. Certification – Manufacturer's certificates that the materials they propose to furnish meet specification requirements.

B. Plant Mix Mortar – If the Contractor chooses to use plant mix mortar the name of the plant mix supplier, together with a summary of his qualifications shall be submitted for approval prior to contracting for his services.

1.3 DELIVERY, STORAGE AND HANDLING

A. Masonry materials shall be stored in dry locations.

B. When stored outdoors, materials shall be loaded on platforms and protected fro the weather with tarpaulins heavy plastic sheeting or other approved means. Mortar materials shall be stored in the building or in watertight sheds. Loose materials shall be protected from intrusion of foreign matter.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Cement

1. Portland Cement (Grey and White) – ASTM C150, Type II, Color gradation as selected by Engineer.
2. Masonry Cement – ASTM C91, Type II.

B. Sand – ASTM C-144. For mortar joints, not less than 95% of the aggregate shall pass a No. 16 sieve. Sand mixed with white masonry cement shall be pure silica sand or white marble dust.

C. Hydrated Lime – ASTM C-207 Type S. Plasticizers other than lime may be used in mortar, with the prior approval of the Engineer.

D. Water

Suitable for drinking (potable).

E. Mortar Coloring - Wherever possible, the desired color (and shade) shall be obtained by the use of different cements and aggregates (such as brown and white cements), rather than by the addition of pigments. When such is not possible, and with the approval of the Engineer, coloring pigments shall be "True Tone Cement Colors" by Frank Davis Co., "Bonsal Cement Colors" by the Bonsal Company, or equal.

2.2 MIXES

A. Proportions (by volume):
   1. 1 part Portland Cement, 1 part Hydrated Lime, 6 Parts Sand
   or
   2. 1 part Masonry Cement, 3 parts sand

PART 3 – EXECUTION

3.1 MIXING

A. Mortar shall be prepared in batches, which shall be used before initial set takes place. Retempering will not be permitted. Mixing shall be thoroughly done by power operated batch mixer, except for small batches of less than one cubic foot, which may be hand mixed. Mixing different types of mortars in the same box will not be permitted. Empty drums of previous batch before charging a new batch.

B. Plant Mix Mortar –
   1. For plant mix mortar, all deliveries of material to the job site shall be accompanied by a certified statement to the effect that the delivery conforms to specification requirements. The statement shall also include the anticipated 28 day compressive strength of the mortar.
   2. Satisfactory on-site facilities shall be provided for storing, handling, and adding water and any other ingredients not incorporated into the mix at the plant.

C. Mortar Grouting and Poured Fills shall have the quantity of water and cement increased to produce the consistency required for pouring and shall be continuously stirred to prevent the segregation of the aggregate.

D. Pointing Mortar shall be of as dry a consistency as will produce a mortar sufficiently plastic to be worked into the joints.

E. Hot-Weather Requirements: When ambient temperature exceeds 100 deg F (38 deg C), or 90 deg F (32 deg C) with a wind velocity greater than 8 mph (13 km/h), do not spread mortar beds more than 48 inches (1200 mm) ahead of masonry. Set masonry units within one minute of spreading mortar.

++ END OF SECTION ++

SECTION 04201

UNIT MASONRY CONSTRUCTION

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all unit masonry construction. The Work also includes:
      a. Providing openings in unit masonry construction to accommodate the Work under this and other Sections and building into unit masonry construction all items such as sleeves, anchorage devices, inserts, and other items to be embedded in unit masonry construction for which placement is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items to be installed with or before unit masonry construction Work.
   2. Remove and rebuild unit masonry construction advanced without built-in flashings and other built-in items at no additional cost to Owner, even after unit masonry construction has been completed.

C. Related Sections:
   1. Section 04060, Masonry Mortaring and Grouting.
   2. Section 04090, Masonry Anchorage and Reinforcing.
   3. Section 04211, Brick Masonry.
   4. Section 04220, Concrete Unit Masonry.
   5. Section 05500, Metal Fabrications.
   6. Section 07620, Sheet Metal Flashing and Trim.
   7. Section 07920, Joint Sealants.

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 530, Building Code Requirements for Masonry Structures.
   2. ACI 530.1, Specification for Masonry Structures.
   3. ASTM C67, Test Methods for Sampling and Testing Brick and Structural Clay Tile.
   4. ASTM C140, Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.

5. ASTM C780, Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unity Masonry.
6. ASTM C1091, Test Method for Hydrostatic Infiltration Testing of Vitrified Clay Pipe Lines.
7. ASTM C1093, Practice for Accreditation of Testing Agencies for Unit Masonry.
8. ASTM C1314, Test Method for Compressive Strength of Masonry Prisms.
9. BIA, Technical Notes on Brick Construction.

1.03 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:
   1. "Masonry control joint" is a joint in interior and exterior masonry walls that allows expansion and contraction to occur independently without damage to the masonry.
   2. "Masonry expansion joint" is a control joint in interior and exterior masonry walls, located at the separation between adjoining parts of a concrete or steel structure that is provided to allow movements transferred to the masonry to occur independently without damage to the masonry.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Installer:
      a. Engage a single installer regularly engaged in preformed unit masonry installation and with successful and documented experience in erecting unit masonry of the scope and type of Work required; and who employs only tradesmen with specific skill and successful experience in the type of Work required. Submit name and qualifications with the following information for a minimum of three successful projects:
         1) Names and telephone numbers of owners, architects, or engineers responsible for projects.
         2) Approximate contract cost of unit masonry.
         3) Quantity (area) of unit masonry installed.
   2. Testing Laboratory:
      a. In accordance with ASTM C1093.

B. Component Supply and Compatibility:
   1. Obtain each type of concrete masonry units from one manufacturer, cured by one process and of uniform texture and color or in an established uniform blend thereof.
   2. Use a single source and brand of mortar materials throughout the Work.

C. Regulatory Requirements:
   1. Where fire-resistance classification is shown or indicated (e.g., four-hour rating, three-hour rating, and similar designations) for unit masonry construction, comply

with applicable requirements for materials and installation established by UL tests referenced in this Section and requirements of authorities having jurisdiction.

D. Job Mock-up:
   1. Prior to installing unit masonry and after Engineer's approval of Samples, erect job mock-ups using materials, pattern bond, and joint tooling shown or specified. Build mock-up at the Site, at location acceptable by Engineer, of full required wall thickness. Mock-up shall be approximately four feet by 3.33 feet unless another size or location is shown or indicated for the job mock-up. Provide special features as directed, including finished opening 16 inches by 16 inches, finished end, and masonry control joint. Indicate proposed range of color, texture, and workmanship to be expected in the completed Work. Obtain Engineer's approval of visual qualities of mock-up before starting unit masonry construction. Retain and protect mock-up during construction as a standard for judging unit masonry Work. Do not alter, move, or destroy mock-up until given permission by Engineer.
   2. Build as many mock-up panels as required to obtain Engineer's approval.
   3. Masonry construction that does not comply with standards approved on mock-up panel shall be removed and rebuilt to conform to the Contract Documents. Provide mock-up panel for the following:
      a. Typical complete exterior walls, including metal cavity wall flashing, anchors and masonry wall ties, and other components of complete exterior wall system.
      b. Typical complete interior partition of concrete unit masonry where both sides will remain visually exposed upon completion of the Work.
      c. Typical interior prefaced concrete masonry partition using all shapes and accessories shown on the approved Shop Drawings and other submittals.
      d. Typical interior partition of concrete unit masonry using all shapes and accessories shown or indicated on the approved Shop Drawings and other submittals.

E. Pre-Construction Masonry Conference:
   1. Prior to installing unit masonry construction, Contractor and Contractor's installer shall attend pre-construction masonry conference at the Site. Review foreseeable methods and procedures related to unit masonry construction including, but not limited to, the following:
      a. Requirements of the Contract Documents.
      b. Structural concept.
      c. Sequence of masonry construction.
      d. Special masonry details.
      e. Standard of workmanship.
      f. Prism and grout sampling, and unit masonry test results.
      g. Quality control requirements.
      h. Project organization and availability of materials, tradesmen, equipment, and facilities required to avoid delays.

i. Masonry control and expansion joint locations and materials.
j. Modular planning requirements.
k. Weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
l. Required inspection, testing, and certifying procedures.
m. Requirements for complying with building codes.

2. Attendance at the conference is mandatory for the following:
   a. Masonry Subcontractor's superintendent and foreman.
   b. Authorized representative of face brick and concrete unit masonry Suppliers.
   c. Engineer
   d. Resident Project Representative.
   e. Coordinating Special Inspector.
3. If additional information is required to adequately cover items on agenda, reconvene conference as soon as possible.
4. Contractor shall record discussions of conference and decisions and agreements (or disagreements) and furnish a copy of the record to each person and entity attending.

1.05 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Complete layout of all masonry walls showing modular planning and all special shapes to be used in the Work. Show all details for each condition encountered in the Work. Submit plan and elevation views drawn at scale of 1/4-inch equal to one foot, and details drawn at scale of 1.5-inch equal to one foot. Show all items included in the unit masonry construction.
      b. Masonry control joint locations and details.
      c. Drawings showing location, extent, and accurate configuration and profile of all items required by the Contract Documents, in this and other Sections, for unit masonry construction. Provide elevations drawn at scale of 1/4-inch equal to one foot, and details drawn at scale of 1.5-inch equal to one foot.
      d. Drawings for fabricating, bending, and placing of reinforcing bars. Submit bar schedules, diagrams of bent bars, stirrup spacing, lateral ties, and other arrangements and assemblies required for fabricating and placing of reinforcing for unit masonry construction.
      e. Job Mock-Up: Shop Drawings showing location, extent, and accurate configuration of items to be built-in to mock-ups. Provide elevations drawn at scale of 1.5-inch equal to one foot.
   2. Samples:
      a. Mock-ups.

B. Informational Submittals: Submit the following:
   1. Field Quality Control Submittals:

a. Pre-installation test results in accordance with ASTM C140 and ASTM C1314, and the field quality control Article of this Section.
b. Post-installation quality control submittals in accordance with the field quality control Article of this Section.

2. Qualifications Statements:
   a. Installer.
   b. Testing laboratory.

C. Closeout Submittals: Submit the following:
1. Record Documentation:
   a. Comply with Section 01720, Project Record Documents.
   b. Indication location of all masonry control joints and expansion joints.

1.06 DELIVERY, STORAGE AND HANDLING

A. General:
1. Comply with:
   a. Section 01600, Materials and Equipment.
2. Storage: Maintain temperatures in shelter so that masonry materials are above 20 degrees F when installed.

1.07 SITE CONDITIONS

A. Environmental Requirements:
1. General:
   a. Temporary Facilities and Temporary Utilities: Provide supplemental heat sources and energy as required for unit masonry construction in cold weather.
   b. Do not perform unit masonry construction when air temperature is below 28 degrees F for rising temperature, or below 36 degrees F for falling temperatures, without providing temporary enclosures and heat, or without heating materials or other measures necessary to prevent freezing as specified.
   c. Do not use frozen materials and do not build on frozen unit masonry construction.
   d. Remove and replace all unit masonry construction damaged by cold temperatures and freezing.
2. Protection:
   a. Cold Weather Protection: Protect unit masonry construction against freezing for at least 48 hours after placement, as follows:
      1) When anticipated minimum temperature will be between 40 degrees F and 25 degrees F, cover newly constructed masonry with weather-resistive membrane for 48 hours after installation.
      2) When anticipated minimum temperature will be between 25 degrees F and 20 degrees F, completely cover newly constructed masonry with weather-resistive insulating blankets, or equal protection, for 48 hours after installation.

3) When anticipated minimum temperature will be below 20 degrees F, maintain newly constructed masonry at temperature above 32 degrees F for at least 48 hours after installation by using heated enclosures, electric heating blankets, infrared lamps, or other acceptable methods of supplementary heating.

b. Hot Weather Protection: When mean daily temperature exceeds 100 degrees F, or exceeds 90 degrees F with wind velocity greater than eight miles per hour, fog-spray newly constructed masonry until damp at least three times per day until masonry is 72 hours old.

c. When Work is not in progress, protect partially-completed unit masonry construction against rapid heat loss and from water entering the masonry by covering top of walls with strong, waterproof, non-staining membrane. Extend membrane at least two feet down both sides of wall and secure in place using wall cover clamps spaced at intervals of four feet and at each end, and at joints in the membrane.

d. Do not apply floor or roof loading for at least 72 hours after completing masonry columns or walls.

e. Do not apply concentrated loads for at least 168 hours after completing masonry columns or walls.

3. Cold Weather Unit Masonry Construction:

a. When mean daily temperature is below 40 degrees F, mortar used in unit masonry construction shall be portland cement-lime-sand mortar using high-early strength portland cement. Use mortar within 1.5 hours of initial mixing. Use grout within 1.5 hours of initial mixing.

b. Clay or shale unit masonry with suctions in excess of 20 grams of water per 30 square inches per minute shall be sprinkled with heated water just prior to installation. Provide water temperature above 70 degrees F when temperature of masonry units is above 32 degrees F. Water temperature shall be above 120 degrees F when temperature of masonry units is below 32 degrees F.

c. For Air Temperatures of 40 degrees F to 32 degrees F: Water and aggregates used in mortar and grout shall not be heated above 140 degrees F. Heat mortar sand or mixing water to produce mortar temperatures between 40 degrees F and 120 degrees F at time of mixing. Heat water and aggregates for grout when water or aggregate temperature is below 32 degrees F.

d. For Air Temperatures of 32 degrees F to 25 degrees F: Comply with this Section and the following: Maintain mortar temperature above freezing until used in masonry. Heat aggregates and mixing water for grout to produce grout temperature between 70 degrees F and 120 degrees F at time of mixing. Maintain grout temperature above 70 degrees F at time of grout placement.

e. For Air Temperatures of 25 degrees F to 20 degrees F: Comply with this Section and the following: Heat masonry surfaces under construction to 40 degrees F. Provide temporary wind breaks or enclosures when wind velocity exceeds 15 miles per hour. Prior to grouting, heat the masonry to minimum of 40 degrees F.

f. For Air Temperatures of 20 degrees F and Below: Comply with this Section and the following: Provide temporary enclosures and auxiliary heat to maintain air temperature within temporary enclosure above 32 degrees F. Temperature of masonry units when laid shall not be less than 20 degrees F.

4. Hot Weather Unit Masonry Construction: Using methods acceptable to Engineer, protect unit masonry construction from direct exposure to wind and sun when ambient air temperature is 99 degrees F in shade with relative humidity less than 50 percent.
   a. When ambient temperature exceeds 100 degrees F, or exceeds 90 degrees F with wind velocity greater than eight miles per hour, maintain temperature of mortar and grout below 120 degrees F. Flush mixers, mortar transport containers, and mortarboards with cool water before they come into contact with mortar ingredients or mortar. Maintain mortar consistency by re-tempering with cool water. Use mortar within two hours of initial mixing. Use grout within 1.5 hours of initial mixing. Maintain sand piles in damp, loose condition.
   b. When ambient temperature exceeds 115 degrees F, or exceeds 105 degrees F with wind velocity greater than eight miles per hour, comply with this Section and the following: Use cool mixing water for mortar and grout. Use of ice will be allowed in mixing water prior to use; ice is not allowed in the mixing water when added to other mortar or grout materials. Shade materials and mixing equipment from exposure to direct sunlight.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Material requirements for masonry materials are in the following:
   1. Section 04060, Masonry Mortaring and Grouting.
   2. Section 04090, Masonry Anchorage and Reinforcing.
   3. Section 04211, Brick Masonry.
   4. Section 04220, Concrete Unit Masonry.

B. Mortar, General:
   1. Where question of compliance with or interpretation of requirements of this Section arises, mortar properties Specification will take precedence over mortar proportion Specifications.
   2. Make no change in proportions established for mortar approved under property Specifications, and do not use materials with different physical characteristics in mortar unless compliance with requirements of property Specifications is re-established by Shop Drawing or submittal data.
   3. Do not combine two air-entraining materials in mortar.

PART 3 – EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which unit masonry construction will be installed, and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Wetting of Masonry Units:
   1. Face Brick: Wet brick having ASTM C67 absorption rates in excess of 20 grams of water per 30 square inches per minute, so that rate of absorption when laid does not exceed the following.
      a. Determine absorption by placing 20 drops of water using medicine dropper inside one-inch diameter circle on typical brick units. If water is absorbed within 90 seconds, wet the brick before laying.
   2. Use wetting methods that ensure that each masonry unit is nearly saturated, but surface-dry when laid.
   3. Concrete Masonry Units: Except for absorbent units specified to be wetted, lay masonry units dry. Do not wet concrete masonry units.

B. Cleaning of Reinforcing: Before placing, remove loose rust, mill scale, earth, ice, and other contamination from reinforcing materials. Do not use reinforcing bars with kinks or bends not shown or approved Shop Drawings, or bars with reduced cross-section due to rusting or other causes.

3.03 INSTALLATION, GENERAL

A. Thickness: Build walls, floors, and other unit masonry construction to thickness shown or indicated. Build single wythe walls to actual thickness of masonry units using units of nominal thickness shown or indicated.

B. Build chases and recesses as shown or required by others, as specified. Provide not less than eight inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

C. Leave openings for equipment, piping, ducts, and other items to be installed subsequent to starting unit masonry construction. After installation of said items, complete unit masonry construction to match the Work immediately adjacent to openings.

D. Cut masonry units using motor-driven wet cutting saws to provide clean, sharp, unchipped edges. Cut units as required to provide pattern shown and to fit adjoining Work neatly. Use full-size units without cutting where possible. Provide special unit masonry shapes for transitions and intersections. Do not attempt to field-cut special shapes from regular unit masonry shapes, and do not use other options for special unit masonry shapes.

E. Build interior masonry walls visible from both sides in the finished Work using two wythes of masonry. Masonry shall be continuous over entire plane of wall, including walls that continue behind fixtures, equipment, furniture, lockers, and similar items

F. Matching Existing Masonry: Match with existing masonry the coursing, pattern bond, color, and texture of new unit masonry construction

3.04 LAYING MASONRY WALLS

A. General:
   1. Mortar Types: Unless otherwise shown or indicated, use mortar specified in Section 04060, Mortar and Masonry Grouting, as follows:
      a. Use Type S mortar for other exterior walls and interior load-bearing walls.
      b. Use Type N mortar for interior, non-load-bearing walls.
      c. Use grout fill for structural requirements and for grouting reinforcing steel in unit masonry construction.
      d. Do not use mortar that has begun to set or if more than thirty minutes have elapsed since initial mixing. Re-temper mortar during the thirty-minute period only as required to restore workability.
   2. Lay out walls in advance for accurate spacing of surface pattern bond with uniform joint widths and to properly locate openings, masonry control joints, returns, and offsets. Avoid using less than half-size units at corners, jambs, and where possible at other locations.
   3. Lay up walls plumb and true to comply with specified tolerances, with courses level, accurately spaced, and coordinated with other work.
   4. Pattern Bond:
      a. Lay exposed interior ground faced concrete unit masonry in a stacked bond pattern with vertical and horizontal joints aligned. Avoid using less than full-size units.
      b. Lay concrete unit masonry scheduled or shown to be concealed by finish materials, except paint, with units in wythe bonded by lapping not less than two inches.
      c. Do not use units with less than four-inch horizontal face dimensions at corners or jambs.
   5. Color and Texture:
      a. Lay brick masonry using mortar of color matching existing construction.
      b. Lay concrete unit masonry using mortar of natural color.

B. Construction Tolerances:
   1. Variation from Plumb: For lines and surfaces of columns, walls and arises, do not exceed 1/4-inch in ten feet, or 3/8-inch in a story height (20 feet), maximum, nor 1/2-inch in 40 feet or more. Except for external corners, expansion joints and other conspicuous lines, do not exceed 1/4-inch in any story or 20 feet maximum, nor 1/2-inch in 40 feet or more.

2. Variation from Level: For lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
3. Variation of Linear Building Line: For position shown and related portion of columns, walls and partitions, do not exceed 1/2-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
4. Variation in Cross Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4-inch nor plus 1/2-inch.

C. Mortar Bedding and Jointing:
1. Lay solid masonry units with completely filled bed and head joint; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.
2. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course of piers, columns, and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout.
3. Maintain joint widths shown, except for minor variations required to maintain pattern bond alignment. If not shown, lay unit masonry to provide the following joint widths:
   a. Brick and Concrete Unit Masonry: 3/8-inch.
4. Cut joints flush for masonry walls to be concealed or to be covered by other materials, except paint, unless otherwise shown.
5. Tool exposed joints slightly concave, when mortar is “thumbprint hard”, unless otherwise required to match existing joint treatment. Rake out mortar 1/2-inch deep in preparation for application of calking or sealants.
6. Concave-tool exterior joints below grade.
7. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners at jambs to fit stretcher units that have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

D. Collar Joints:
1. Fill vertical space between wythes solidly with mortar by parging the in-place wythe and shoving units into the parging.

E. Stopping and Resuming Work: Rake back one unit masonry length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly, if required, and remove loose masonry units and mortar prior to laying new masonry.

F. Built-in Work:
1. As the Work progresses, build-in the items shown, specified or required in the Contract Documents. Fill cores in one-block width solidly with mortar around built-in items.
2. Do not fill space between hollow metal frames and masonry solidly with mortar.
3. Where built-in items are to be embedded in cores of hollow masonry units, place layer of cavity fill mesh in the joint below and rod mortar or grout into core.

4. Where required by Laws or Regulations, or to comply with thickness-to-height ratio, or to provide required fire resistance, fill all cells of unit masonry construction solid with grout.

G. Structural Bonding of Multi-Wythe Masonry:
   1. Use individual metal ties embedded in horizontal joints to bond wythes together Refer to Section 04090, Masonry Anchorage and Reinforcing, for type of ties required. Provide ties as shown, but not less than one metal tie for four square feet of wall area spaced not to exceed two feet on centers horizontally and vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than three feet apart around perimeter of openings.
   2. Use continuous reinforcing embedded in horizontal mortar joints for bond tie between wythes as specified in this Section.
   3. Corners: Provide interlocking masonry unit bond in each course at corners, unless otherwise shown or indicated.
      a. For horizontally reinforced masonry, provide continuity at corners with prefabricated "L" units as specified in this Section, in addition to masonry bonding.
   4. Intersecting and Abutting Walls: Unless vertical expansion or masonry control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:
      a. Provide masonry bond in alternate courses.
      b. Provide individual metal ties at not more than two feet on centers vertically.
      c. Provide continuity with horizontal joint reinforcing using prefabricated "T" and "L" units.

H. Non-Load-Bearing Interior Partitions and Non-Load-Bearing Interior Cavity Wall Wythe:
   1. Build full height of story to underside of structure above, unless otherwise shown or indicated.
   2. Tie non-load-bearing partitions and non-load-bearing interior wythe of cavity walls at top and sides with masonry anchors at terminations. Build in end blocks as shown and specified to facilitate placing compressible filler. Insert compressible filler, specified in Section 04090, Masonry Anchorage and Reinforcing, in all horizontal and vertical joints where non-load-bearing masonry and non-load- bearing interior wythe of cavity walls terminate. Insert filler 3/4-inch from both faces of masonry. Use filler four times as thick as widest part of joint. Thickness of filler shall be a minimum of 1.5 times the compressed thickness. Compress filler to less than thickness of joint and insert. At splices, overlap strips by three inches and compress ends to form tight joint. Finish with backer rod and sealant.
   3. At terminations of non-load-bearing masonry walls and non-load-bearing interior wythe of cavity walls requiring a fire rating, use fire-safing insulation specified in Section 07210, Building Insulation. Build in end blocks to facilitate placing

fire-safing insulation. Insert insulation in a continuous, vapor-tight, solid blanket to 3/4-inch from both faces of masonry. Finish with backer rod and sealant.

I. Cavity Walls:
   1. Verify that fluid applied membrane air barrier is installed.
   2. Position insulation as shown and in accordance with Section 07210, Building Insulation.
   3. Install cavity drainage material.
   4. Keep cavity clean of mortar droppings during construction by using continuous horizontal board of same width as cavity with lifting wires at each end. Lift board upward before placing horizontal joint reinforcing. Clean mortar droppings from board. Do not clean into cavity. Joints facing cavity shall be struck flush.
   5. Tie exterior wythe to back-up with individual metal ties spaced not more than 16 inches on centers vertically and 16 inches on centers horizontally. Stagger in alternate courses.
   6. Tie exterior wythe to back up with continuous horizontal joint reinforcing, embedded in mortar joints at not more than 16 inches on centers vertically. Refer to Section 04090, Masonry Accessories, for type of reinforcing required.
   7. Provide weep holes in exterior wythe of cavity wall located in wall foundation courses and immediately above ledges and flashing, spaced two feet on centers, unless closer spacing is shown or indicated. Install plastic weep tubes. Keep weep holes free of mortar and other obstructions.
   8. Provide weep vents in exterior wythe of cavity wall in wall top courses and immediately below ledges and flashing, spaced two feet on centers, unless closer spacing is shown or indicated. Provide plastic weep vents. Keep weep vents free of mortar and other obstructions.

J. Horizontal Joint Reinforcing:
   1. Provide continuous horizontal joint reinforcing as shown and specified. Refer to Section 04090, Masonry Accessories, for reinforcing units required. Fully embed longitudinal side rods in mortar for entire length of rods with minimum cover of 5/8-inch on exterior side of walls and 1/2-inch at other locations. Lap reinforcing minimum of six inches at ends of units. Do not bridge masonry control joints and building expansion joints with reinforcing.
   2. Reinforce walls with continuous horizontal joint reinforcing unless specifically indicated as being omitted.
   3. Provide continuity at corners and wall intersections by using prefabricated “L” and “T” sections. Cut and bend units in accordance with manufacturer’s written instructions for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.
   4. Space continuous horizontal reinforcing as follows:
      a. For multi-wythe walls, solid or cavity, that are structurally bonded by masonry headers or individual wire ties, space horizontal reinforcing two feet on centers vertically.

b. For multi-wythe walls, solid or cavity, where continuous horizontal reinforcing also acts as structural bond or tie between wythes, space reinforcing as required by Laws and Regulations, but not more than 16 inches on centers vertically.
c. For single-wythe walls, space reinforcing at 16 inches on centers vertically, unless otherwise shown.
d. For parapets, space reinforcing at eight inches on centers vertically, unless otherwise shown.

5. Reinforce masonry openings greater than 12 inches wide, with horizontal joint reinforcing placed in two horizontal joints approximately eight inches apart, immediately above lintel and immediately below sill. Extend reinforcing a minimum of two feet beyond jambs of opening.
6. In addition to wall reinforcing, provide additional reinforcing at openings as required to comply with the above.

K. Structural Reinforced Unit Masonry Construction:
1. Comply with ACI 530, ACI 530.1 and Laws and Regulations for structural reinforced unit masonry construction.
2. Shape and dimension reinforcement as shown and required by applicable ACI standards and Laws and Regulations.
3. Position reinforcing accurately at spacing shown on approved Shop Drawings. Support and secure vertical bars against displacement using rebar positioners.
4. Where vertical bars are shown in close proximity, provide clear distance between bars of not less than the greater of the nominal bar diameter or one-inch.
5. Provide lapped splices with reinforcing steel placed in contact and wire tied. Provide minimum lap required by Laws and Regulations, unless requirements that are more stringent are shown or indicated. Do not splice reinforcing at points other than shown or as approved on Shop Drawings.
6. Provide substantial and tight formwork and shores as required for temporary support of reinforced masonry elements. Design, erect, support, brace, and maintain formwork.
7. Construct formwork to conform to shape, line and dimensions shown. Make sufficiently tight to prevent leakage of mortar grout. Brace, tie, and support as required for maintaining position and shape during construction and curing of reinforced masonry.
8. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and all other temporary loads that may be placed on them during construction.
9. Allow not less than the following duration to elapse after completing a member before removing shores or forms, provided suitable curing conditions have been obtained during the curing period:
a. Girders and Beams: Ten days.
b. Slabs: Seven days.
c. Reinforced Masonry Soffits: Seven days.

L. Grouting Structural Reinforced Unit Masonry Construction:
   1. Limit extent of masonry construction to sections that do not exceed the maximum pour requirements specified. Provide temporary dams or barriers to control horizontal flow of grout at ends of wall sections. Build dams to full height of grout pour. If masonry units are used, do not bond into permanent masonry wythes. Remove temporary dams after completing grout pour.
   2. Use fine grout for filling spaces less than four inches in both horizontal directions. Use coarse grout for filling spaces four inches or larger in both horizontal directions.
   3. For spaces 10 inches and larger, use concrete fill.
   4. Low-Lift Grouting:
      a. Use low-lift grouting techniques using fine grout mix for the following:
         1) Two-wythe walls with grout space of two inches or less in width.
         2) Multi-wythe walls.
         3) Grout spaces less than 2-inches in width at intervals not to exceed two feet in lifts of six to eight inches.
         4) At Contractor's option, low-lift-grouting technique may be used for structural reinforced unit masonry construction with grout spaces wider than two inches, except use coarse grout mix and place in lifts not to exceed eight inches in height.
      b. Construct low-lift structural reinforced unit masonry construction by placing reinforcing, laying masonry units and pouring grout as the Work progresses.
      c. Place vertical reinforcing bars and supports prior to laying of masonry units. Extend above elevation of maximum pour height as required to allow for splicing. Horizontal reinforcing bars may be placed progressively with laying of masonry units.
      d. Limit grout pours as required to prevent displacing masonry by grout pressure (blowout), but do not exceed 12-inch pour height.
      e. Lay masonry units prior to each grout pour, but do not construct more than 12 inches above maximum grout pour height in one exterior wythe and four inches above in other exterior wythe. Provide metal wall ties, if required, to prevent blowouts.
      f. Pour grout using container with spout and consolidate immediately by rodding or puddling; do not use trowels. Place grout continuously; do not interrupt pouring of grout for more than one hour. If poured in lifts, place from center-to-center of masonry courses. Terminate pour 1.5 inches below top of highest course in pour.
   5. High-Lift Grouting:
      a. High-lift grouting technique may be used for the following structural reinforced unit masonry construction:
         1) Two-wythe walls with grout spaces of 2.5 inches or greater width.
      b. Place reinforcing and support in proper position, prior to laying of masonry units, except if shown to be placed in mortar joints, place as masonry units are laid. Place horizontal bars in grout spaces on same side of vertical bars.

c. Construct high-lift structural reinforced unit masonry construction by laying masonry to full height and width prior to placing of grout. Provide cleanout holes in first course of masonry, and use high-pressure water jet stream to remove excess mortar from grout spaces, reinforcing bars and top surface of structural members, which support wall. Clean grout spaces daily during construction of masonry.
d. Walls: Omit every other masonry unit in first course of one wythe to provide cleanout holes. Tie wythes together with metal ties as shown or required by Laws and Regulations, but provide not less than nine-gage wire ties spaced not less than two feet on centers horizontally and 16 inches on centers vertically for running pattern bond or 12 inches on centers vertically for stack bond.
e. Preparation of Grout Spaces: Prior to grouting, inspect and clean grout spaces. Remove dirt, dust, mortar droppings, loose pieces of masonry, and other foreign materials from grout spaces. Clean reinforcing and adjust to proper positioning. Clean top surface of structural members supporting masonry to ensure bond. After cleaning and inspection, close cleanout holes with matching masonry units and brace closures to resist grout pressures.
f. Place grout after entire height of masonry to be grouted has attained sufficient strength to resist grout pressure, but not less than three days curing time. Install shores and bracing, if required, before starting grouting operations.
g. Place grout by pumping into grout spaces, unless alternate methods are acceptable to Engineer.
h. Use coarse grout mix. Rod or vibrate each grout lift during placing and again after excess moisture has been absorbed, but before plasticity is lost. Do not penetrate or damage grout placed in previous lifts or pours.
i. Limit grout pours to sections that can be completed in one working day with not more than one-hour interruption of pouring operation. Limit pours to not exceed capacity of masonry to resist displacement or loss of mortar bond due to grout pressures.
    1) Do not exceed 12 feet pour height.
    2) Do not exceed 25 feet horizontal pour dimension.
j. Where pour height exceeds four feet place grout in series of lifts not exceeding four feet in height. Place each lift as continuous pouring operation. Allow at least 30 minutes and not more than 60 minutes between lifts of each pour.
k. When more than one pour is required to complete a section of masonry, extend reinforcing beyond masonry as required for splicing. Pour grout to within 1.5 inches of top course of first pour. After grouted masonry is cured, remove temporary dams, lay masonry units, and place reinforcing for second pour section before grouting.

M. Anchoring Masonry Work:
1. Provide anchoring devices as specified under Section 04090, Anchorage and Reinforcing. If not shown or indicated, provide standard type for facing and back-up involved in compliance with Laws and Regulations.

2. Anchor masonry to structural members where masonry abuts or faces such members to comply with the following:
    a. Provide an open space not less than a 1/2-inch or more than one-inch in width between masonry and structural members, unless otherwise shown. Keep open space free of mortar and other rigid materials.
    b. Anchor masonry to cast-in-place concrete and structural steel members with metal ties embedded in masonry joints and attached to structure. Provide anchors with flexible tie sections.
    c. Space anchors as shown, but not more than two feet on center vertically and three feet on centers horizontally.
    d. Provide end blocks where masonry abuts structural support to facilitate installation of compressible filler, fire-safing insulation, backer rod, and sealant.
3. Anchor single-wythe masonry veneer to backing with metal ties as follows:
    a. Anchor veneer to structural members with metal anchors embedded in masonry joints and attached to structure. Provide anchors with flexible tie section, unless otherwise shown.
    b. Anchor veneer to concrete back-up with dovetail anchors and to structural steel back-up with slotted anchors.
    c. Space anchors as shown, but not more than two feet on centers vertically and three feet on centers horizontally.

N. Masonry Control and Expansion Joints:
1. Provide vertical expansion and control joints in masonry where shown. Build in related items as unit masonry construction progresses. Rake out mortar in preparation for application of calking and sealants, in accordance with Section 07920, Joint Sealants.
2. Provide masonry control and expansion joints items specified under Section 04090, Masonry Anchorage and Reinforcing where masonry control and expansion joints are shown.
    a. Build-in compressible fillers as specified. Install in accordance with manufacturer's written instructions.
    b. Build-in factory-premolded control joint strips into masonry. Build-in sash block and premolded control joint strips as the Work progresses.
    c. Provide end blocks where masonry partitions abut structure to facilitate installation of compressible filler, fire-safing insulation, backer rod, and sealant.
3. Brick Masonry Control Joint Spacing: Where location of masonry control joints are not shown, place vertical joints spaced not to exceed 50 feet on centers for clay masonry and 35 feet on centers for concrete masonry wythes if reinforced, or 30 feet on centers for unreinforced concrete masonry wythes. Provide masonry control joints at points of natural weakness in unit masonry construction including the following:
    a. At structural column or joint between bays.
    b. Above expansion or control joints in the supporting structure.

c. Above major openings at end of lintels upward, and below at ends of sills downward. Place at one side of jamb for openings less than six feet wide and at both sides for openings over six feet wide.
d. At vertical chases, recesses and other points of reduction in wall thickness.
e. At locations where masonry wall height changes by more than 20 percent.
f. Where masonry abuts supporting structure.
g. At distance equal to half the wall height from corners or intersections with other masonry.
h. Submit locations of joints in Shop Drawings.

4. Masonry Control and Expansion Joint Spacing: Provide masonry control and expansion joints as shown.

O. Lintels and Bond Beams:
1. Provide steel lintels where shown and as specified in Section 05500, Metal Fabrications.
2. Provide masonry lintels and bond beams where shown and where openings of 16-inches or greater are shown without structural steel lintels. Provide formed-in-place masonry lintels and bond beams. Temporarily support formed-in-place lintels and bond beams.
a. Unless otherwise shown or indicated, provide one horizontal No. 4 deformed reinforcing bar for each four inches of wall thickness.
b. For hollow masonry unit walls, use specially formed U-shaped lintel and bond beam units with reinforcing bars placed as shown, filled with grout as specified in Section 04060, Masonry Mortaring and Grouting.
3. Provide minimum bearing at each jamb, of four inches for openings less than six feet wide, and eight inches for wider openings.
4. On concrete and clay unit masonry walls where pattern bond remains visually exposed, increase minimum bearing of masonry lintels to maintain joint pattern of wall and install to be indistinguishable from surrounding masonry.

P. Flashing of Masonry Work:
1. Provide concealed flashings in masonry Work as shown or indicated. Refer to Section 07620, Sheet Metal Flashing and Trim, for flashing requirements. Prepare masonry surfaces smooth and free from projections that might puncture flashing. Place through-wall flashing on bed of mortar and cover with mortar. Seal flashing penetrations with mastic before covering with mortar. Terminate flashing 1/2-inch from face of wall, unless otherwise shown or indicated.
a. Extend flashings beyond edge of lintels and sills at least four inches and turn up edge on sides to form pan to direct moisture to exterior.
b. Interlock end joints of deformed metal flashings by overlapping deformations not less than 1.5 inches and seal lap with elastic sealant.
c. Install flashings in accordance with manufacturer’s instructions and approved Shop Drawings and other submittals.
d. Provide flexible flashings in accordance with manufacturer’s instructions and approved Shop Drawings and other submittals.

2. Provide weep holes in head joints of first course of masonry immediately above concealed flashings. Spacing is specified elsewhere in this Section.
3. Install reglets and nailers for flashing and other related Work where shown to be built into unit masonry construction.
4. Install flexible masonry flashing into cast-in-place elastic masonry flashing reglets with lead wedges and fill reglet with elastic flashing manufacturers recommended bonding rubber-based adhesive cement.

3.05 REPAIR, POINTING AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or defective, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing: During tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point up all joints at corners, openings, and adjacent Work to provide a neat, uniform appearance, properly prepared for application of sealant compounds.

C. Cleaning Exposed, Unglazed Masonry Surfaces:
   1. Wipe off excess mortar as the Work progresses. Dry-brush at end of each day's work.
   2. Final Cleaning: After mortar is thoroughly set and cured, clean sample wall area of approximately 20 square feet as described below. Obtain Engineer's acceptance of sample cleaning before proceeding to clean remainder of masonry Work.
      a. Dry clean to remove large particles of mortar using wood paddles and scrappers. Use chisel or wire brush if required.
      b. Presoak wall by saturating with water and flush off loose mortar and dirt.
      c. Scrub down wall with stiff fiber brush and solution of half-cup of sodium hexameta phosphate and half-cup of household detergent dissolved in one gallon of water.
      d. Rinse walls, using clean, pressurized water, to neutralize cleaning solution and remove loose material.
      e. Acid cleaning of masonry is unacceptable.

D. Protection:
   1. Protect the unit masonry construction from deterioration, discoloration, and damage during subsequent construction operations. At areas where items are installed that project from the finish plane of masonry walls, such as concrete curbs, precast concrete sills, and the like, immediately upon completion of the projecting portion of the Work, provide a minimum 3/4-inch thick plywood cover, cut to fit, to prevent damage from operations continuing above the work. Refer to Section 06100, Rough Carpentry.

3.06 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Pre-construction Testing:
      a. Engage independent testing laboratory to obtain samples and conduct the following tests prior to the start of installation of unit masonry construction:
         1) Mortar Test: For each mix required: ASTM C780.
         2) Grout Test: For each mix required: ASTM C1019 and ACI 530.1.
         3) Prism Test: For each type of construction required: ASTM C1314 and ACI 530.1.
         4) Compressive strength of completed concrete unit masonry walls shall be at least 1,500 psi as determined by methods in ACI 530.1.
      b. Obtain Engineer's acceptance of tests results prior to commencing installation of materials.
      c. After initial test, Engineer will require performance of up to five additional tests Engineer's discretion.
   2. During and After Installation:
      a. Comply with Section 01416, Special Inspections:
      b. Test and inspect unit masonry during construction in accordance with quality assurance program defined in ACI 530, ACI 530.1 and Laws and Regulations in effect at the Site, including building code. Level of special inspections shall comply with requirements of International Building Code classification and occupancy.
   3. Repair masonry walls that do not comply with requirements of the special inspections in a manner acceptable to Engineer.

+ + END OF SECTION + +

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SECTION 04211

BRICK MASONRY

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified and required to furnish and install all brick masonry.
   2. Exent of each type of brick masonry is shown.
   3. Types of products required include:
      a. Custom shapes, profiles, textures, colors, and sizes.
      b. Brick masonry units required to match existing.

B. Related Sections:
   1. Section 04201, Unit Masonry Construction.
   2. Section 04220, Concrete Unit Masonry.

1.02 REFERENCES

A. Reference Standards: Standards referenced in this Section are:
   1. ASTM C216, Specifications for Facing Brick (Solid Masonry Units Made from Clay or Shale).

1.03 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Obtain each type of brick masonry from one manufacturer, of uniform texture and color or uniform blend in the variation thereof, for each continuous area and for visually related areas.
   2. Do not change source or brands of brick masonry materials during the Work.

B. Regulatory Requirements:
   1. Where a fire-resistance classification is shown or scheduled for brick masonry (four-hour, three-hour and similar designations), provide brick masonry complying with requirements established by UL tests referenced in this Section, applicable codes, and authorities having jurisdiction.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:

a. Submit copies of brick manufacturer's specifications and test data for each type of brick masonry required.

2. Samples:
   a. Straps of each type of brick masonry specified. Select units to show range of color and texture expected in finished Work.
   b. Each type of custom molded brick masonry shapes shown or required.
   c. Engineer's review will be for color and texture only. Compliance with other requirements is responsibility of Contractor.

B. Informational Submittals: Submit the following
   1. Certifications:
      a. Recycle Content Face Brick Certifications:
         1) Proof of compliance with requirements of federal and state authorities having jurisdiction regarding processing of recycled material transportation, testing, and handling.
         2) Proof of successful operation and production of face brick units as specified.
      b. Certification of Compliance: Submit certification that each type of brick masonry required complies with the Contract Documents and applicable referenced standards.
   2. Supplier Instructions:
      a. Submit instructions for handling, storing, installing, and protecting each type of brick masonry.
   3. Source Quality Control Submittals:
      a. Submit for approval laboratory testing acceptable to Engineer establishing minimum recycle content of face brick.

PART 2 – PRODUCTS

2.01 BRICK SIZE

A. Size: Unless otherwise shown or specified, provide standard modular-size brick for 3/8-inch mortar joints. Actual size for exposed vertical brick when laid as a stretcher shall be 7-5/8 inches long by 2-1/4 inches high by 3-5/8 inches wide.
   1. Provide custom-molded shapes, profiles, and sizes where shown and for applications that cannot be sawed from standard brick sizes.
   2. Where specified brick masonry is comprised of a mix or range of colors or textures, provide custom-molded brick masonry shapes in same mix or range of colors and textures as brick masonry specified.

B. Size: Unless otherwise shown or specified, provide nominal eight-inch by eight-inch by four-inch brick. Actual size for exposed vertical brick masonry shall be 7-5/8 inches by 7-5/8 inches by 3-5/8 inches.
   1. Provide custom-molded shapes, profiles, and sizes where shown and for applications that cannot be sawed from standard brick sizes.

2. Where specified brick masonry is comprised of a mix or range of colors or textures, provide custom-molded brick masonry shapes in same mix or range of colors and textures as brick masonry specified.

2.02 BRICK

A. Solid Face Brick: ASTM C216, Grade SW, of the following types, design intent is to match the existing brick in size, color, and finish:
   1. Type FBX.
   2. Color and Texture:
      a. Provide blended brick colors to match existing brick on the Primary Settling Tanks Building in both color, texture and brick face finish.
      b. Basis-of-Design Brick: Belden Brick Modular 691-693 Smooth.
   3. Where shown or specified to "match existing", provide brick of matching custom color, texture, shape, and size. Provide handmade shapes required to match existing detail and ornamentation.
   4. Manufacturers: Provide one of the following:
      a. Belden Brick.
      b. Consolidated Brick.
      c. Hebron Brick Company.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Refer to the following:
   1. Section 04201, Unit Masonry Construction.
   2. Section 04220, Concrete Unit Masonry.

+ + END OF SECTION + +

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SECTION 04220

CONCRETE UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Unit masonry as specified herein shall include, but not be limited to, concrete masonry units, ground face concrete masonry units, acoustic masonry units, reinforcement, anchorage, and all accessories and appurtenances. Unit masonry items shall be provided where shown on the Contract Drawings, specified herein, or as required for a complete installation.

1.02 RELATED SPECIFICATIONS

A. Section 04201 – Unit Masonry Construction

B. Section 04211 - Brick Masonry

C. Section 03600 – Grouting

D. Section 04100 – Mortar

E. Section 05500 – Metal Fabrications

F. Section 07272 – Air and Water Barrier

G. Section 07620 – Sheet Metal Flashing and Trim

1.03 REFERENCES

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

B. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

C. ASTM C90 - Specification for Load-Bearing Concrete Masonry Units

D. ASTM C126 - Ceramic glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units

E. ASTM C216 - Specification for Facing Brick (Solid Masonry Units Made From Clay or Shale)

F. Masonry Standards Joint Committee (MSJC):
   1. ACI 530/ASCE 5/TMS 402 - Building Code Requirements for Masonry Structures
   2. ACI 530.1/ASCE 6/TMS 602 - Specification for Masonry Structures

G. NYSBC - New York State Building Code

1.04 DESIGN REQUIREMENTS

A. Provide masonry accessories of sizes, dimensions and configurations coordinated with unit masonry construction system component sizes, dimensions and configurations.

B. Where continuous horizontal cavity wall reinforcement is specified as providing restraint for cavity wall insulation, coordinate dimensions with thickness of cavity wall insulation specified for proper clearances.

C. Where structural steel will be provided with fireproofing do not use welded-on channel slots. Coordinate required offset of welded-on wire ties with depth of fireproofing.

D. Concrete Masonry Units: Limit total moisture absorption until time of installation to the maximum percentage specified for Type I units for the average annual relative humidity as reported by the United States Weather Bureau Station nearest the Site and the corresponding percentage of total linear drying shrinkage of the concrete masonry units.

E. Comply with ASTM C90 Climatic Map establishing criteria for percent annual mean relative humidity.

F. Structural elements of masonry shall conform to the requirements of ACI 530/ASCE 5/TMS 402 for materials and installation.

G. Masonry materials and installation shall conform to the requirements of ACI 530.1/ASCE 6/TMS 602.

1.05 SUBMITTALS

A. The Contractor shall prepare and submit for approval catalog cuts, drawings, and reference materials in accordance with the General Conditions. Submittals shall include the following:
   1. Samples: The Contractor shall submit three samples each of type of concrete masonry unit that are representative of the full range of color, shading and texture of the material to be provided.
   2. Test Reports: The Contractor shall submit material test reports or manufacturer's certificate of compliance for face brick, structural glazed brick, concrete masonry units, and glazed structural tile.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer’s specifications and installation instructions for each masonry accessory required. Include data substantiating that materials comply with specified requirements.
   2. Provide drawings and material schedules showing all dimensions and sizes of masonry accessories coordinated with unit masonry construction work, and other

work in which masonry accessories will be embedded, be supported from, or restrain.

3. Indicate methods for identifying and coordinating, at the Site, the location and accurate placement of each masonry accessory in unit masonry construction as the work progresses. Indicate by letter of transmittal that items which must be installed in the shop have been received in time for proper sequencing of the work to avoid delays.
4. Complete layout of all unit masonry walls showing modular planning and all special shapes to be used in the work. Show all details for each condition encountered in the work. Provide plan and elevation views drawn at 1/4- inch scale and details drawn at 1-1/2-inch scale. Show all items required to be built into unit masonry construction.
5. Masonry control joint locations and details.
6. Drawings showing the location, extent and accurate configuration and profile of all items shown, specified and required by this and other Sections to be built into the unit masonry construction as the work progresses. Provide elevations drawn at 1/4-inch scale and all details drawn at 1-1/2- inch scale.
7. Drawings for fabrication, bending, and placement of reinforcing bars. Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies as required for fabrication and placement of reinforcing for unit masonry construction.

C. Informational Submittals:
   1. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
      a. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
   2. Material Certificates: For each type and size of the following:
      a. Masonry units.
         1) Include data on material properties material test reports substantiating compliance with requirements.
         2) For masonry units, include data and calculations establishing average net-area compressive strength of units.
      b. Cementitious materials. Include brand, type, and name of manufacturer.
      c. Pre-blended, dry mortar mixes. Include description of type and proportions of ingredients.
      d. Grout mixes. Include description of type and proportions of ingredients.
      e. Anchors, ties, and metal accessories.
   3. Mix Designs: For each type of mortar. Include description of type and proportions of ingredients.

a. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
b. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

4. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 402/602.
5. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.06 QUALITY ASSURANCE

A. Special Inspections:
1. Testing Agency Qualifications: Qualified according to ASTM C1093 for testing indicated.
2. In accordance with the Statement of Special Inspections, the Special Inspector shall provide, and coordinate inspections and verifications as noted on Contract Drawings.
3. Special Testing Inspections: Owner shall employ a Special Inspection Agency to provide required inspections in accordance with current Building Code of New York State.
4. The Special Inspector shall submit copies of reports to Architect, Engineer, Owner's Site Representative and Contractor on day that tests are made. Include date of testing, weather conditions, building location and test location.

B. Requirements of Regulatory Agencies: Wherever a fire-resistance classification is shown or scheduled for unit masonry construction (2-hour, 3-hour and similar designations), provide masonry accessories, masonry units and unit masonry construction complying with the requirements established by UL and other governing authorities having jurisdiction at the Project Site.

C. Source Quality Control: Provide all metal sheet, wire, plate and bar stock masonry accessories from the same manufacturer.

D. Mock Up: The Contractor shall erect a 4 foot long by 3 foot high sample panels for each color of filled ground face concrete masonry units to be used in the work.
1. The mock up shall include facing veneer, bond pattern, mortar color, tooled joints, insulation, reinforcing and backup.
2. Upon approval, the mock up shall remain in place for the duration of masonry construction and shall be used as a basis of comparison for all masonry work.
3. After final approval of finished masonry work by the Engineer, the Contractor shall demolish the mock up, and shall perform all site restoration work.

E. Manufacturer Qualification: Acoustical CMUs (ACMUs) shall be made on standard block machines using molds furnished or approved by the manufacturer to assure uniform quality. ACMUs shall be made with the same materials, concrete/aggregate mix design, manufacturing process, and curing methods as standard CMUs that have been tested according to current ASTM C140/C140 Standards to meet current ASTM C90 Standard requirements for Strength, Absorption, Density, and Linear Dry Shrinkage.

1.07 DELIVERY, STORAGE, AND HANDLING

A. General: All products and materials shall be delivered, stored, and handled as follows.

B. Delivery and Storage: Masonry materials delivered and stored at the site shall be from approved manufacturers and sources only.

C. Masonry Units:
   1. Masonry units shall be handled in a manner which prevents undue breakage or chipping.
   2. Face brick and concrete masonry units shall be unloaded using brick clamps.
   3. All masonry units shall be stored on platforms under shelter or in another approved manner so as to protect these materials from soil and weather.

D. Rejection: Face bricks, structural glazed bricks, glazed structural tile, concrete masonry units, ground face concrete masonry units, and acoustical concrete masonry units that are warped, cracked or of inferior quality will be rejected. Such items shall be removed from the site and not offered again for inspection.

E. Manufactured materials, such as lime and cement, shall be delivered and stored in their original containers, plainly marked with identification of material and maker. Materials in broken containers, or in packages showing water marks or other evidence of damage, shall not be used and shall be removed from site.

F. ACMUs are to be handled to protect faces and edges from chipping. ACMUs shall be installed by the General Contractor (or Masonry Contractor), using only mechanics skilled in the laying of masonry units. Jobsite cutting of ACMUs shall be performed with power tools in such a manner as to provide straight and true edges.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Filled Ground Face Concrete Masonry Units (GFB) as manufactured by the following or approved as equal to:
   1. Jandris Block, 202 High Street, Gardner, MA 01440. Tel. 978-632-0089, Fax: 978-632-6065. www.ajandris.com
   2. Verrastone Plus masonry units by Trenwyth Industries, Incorporated. One Connelly Road Emigsville, PA 17318, Tel. 717 767-6868, www.trenwyth.com.

3. Pozzotive Ground Faced with Crystal Coat Plus masonry units by Kingston Block & Masonry Supply Company, 20 Keifer Lane, Kingston, NY 12401, Tel. 845 338-9900, Fax 845 338-8400, www.kingstonblock.com.

B. Concrete Masonry Units as manufactured by the following or approved equal to:
   1. Trenwyth Industries, Incorporated. One Connelly Road, Emigsville, PA 17318, Tel. 717 767-6868, www.trenwyth.com
   2. Ground Face masonry units by Westbrook Concrete Block, 439 Spencer Plains Road, Westbrook CT, 06498, Tel. 860-399-6201, https://www.westbrookblock.com/products/ground-face/

C. Integral Block Water Resistive Additive shall be provide by the following or approved as equal to:
   1. W.R. Grace DRY-BLOCK as distributed by Trenwyth Industries One Connelly Road Emigsville, PA 17318, Tel. 717 767-6868, www.trenwyth.com.

D. Sound-Absorbing Concrete Masonry Units shall be provide by the following or approved as equal to:
   1. SOUNDBLOX® by Sound Seal, 50 H.P. Almgren Drive, Agawam, MA 01001; Tel. (800) 569-1294 (413) 789-1770; Fax (413) 789-4444. dgilbert@soundseal.com.

2.02 MATERIALS

A. Concrete Masonry Units: Concrete masonry units shall be manufactured with lightweight aggregate and shall be provided as follows:
   1. Hollow Load-Bearing Units: Hollow load-bearing units shall conform to ASTM C90, Type I for exterior walls, foundation walls, interior load- bearing and nonload-bearing walls and partitions. Units shall have a compressive strength of 3,000 psi over the net area.
   2. Solid Load-Bearing Units: Solid load-bearing units shall conform to ASTM C90, Type I, except units exposed to weather shall be Grade U. Solid units shall be provided for masonry bearing under structural framing members and for fireproofing of steel structural members. Units shall have a compressive strength of 3,000 psi over the net area.
   3. Special Shapes: Special shapes, such as closures, header units, and jamb units shall be provided as necessary to complete the work. Special shape units shall conform to the applicable provisions for the units with which they are used.
   4. Recycle Content: Replacement of cement portion of Concrete Masonry Units of a minimum of either 20% post consumer content or 38% Pre- consumer recycled content.
   5. Face Size: 7-5/8-inch by 15-5/8-inch. Unless notes otherwise.

B. Filled Ground Faced Concrete Masonry Units (GFB): Provide units with water resistive additive and face of units filled with a cementitious grout with a minimum cured strength and durability equal to the concrete masonry units. After polishing, the filled

surface shall have a factory applied heat treated acrylic coating conforming to the requirements of ASTM C744 with respect to adhesion, abrasion, color change and resistance to fading or in lieu of filling of GFB coat with UV cured coating system compliant with ASTM E514 for water seal, apply Crystal Coat Plus or approved equal. Provide the following:

1. Manufacturer's units complete selection of all standard and custom colors for final selection by the Engineer. Chosen colors are Jandris Ground Face Block White 5110-G.
2. Recycle Content: Replacement of cement portion of Filled Ground Faced Masonry Units of a minimum of either 20% post consumer content or 38% Pre-consumer recycled content.
3. Color, surface texture and aggregate uniform within the normal range established by sample submission and as approved by the Engineer.
4. Provide white sand mortar for white units and mortar color matching the units selected. Mortar color match to units are a provided by the manufacturer of Filled Ground Faced Concrete Masonry Units.
5. The Engineer will select a maximum of eight colors for the work.
6. All vertical outside corners to be bullnose shape.
7. Face Size: 7-5/8-inch by 15-5/8-inch.
8. Integral Water Resistive Additive: Shall comply with the following ASTM standards:
    a. ASTM E-514 – display no penetration of water during 72-hours of testing. Rating class E no dampness reported.
    b. ASTM C140 – shall exceed strength standards in all cases when compared with control blocks.
    c. ASTM C67 – shall have ¼ the initial Rate of Absorption when compared with control blocks.
    d. ASTM 1070 – Lab tests shall indicate no difference between bond strength of blocks when compared with control blocks.
    e. ASTM C780 – mortar cures average 12% greater compressive strength.
    f. ASTM E90-86 – pass (Display of “breathability or compatibility to bar water entry while allowing moisture vapor to escape”)

C. Acoustical Concrete Masonry Units (ACMU): Provide ACMUs with two apertures formed on their faces to provide sound absorption into the ACMU’s cavities.

1. ACMUs shall be made on standard block machines using molds furnished or approved by the manufacturer, materials and finish shall be the same as GFB
2. Manufacturer's units complete selection of all standard and custom colors for final selection by the Engineer. Chosen colors are Jandris Ground Face Block White 5110-G.
3. Provide white sand mortar for white units and mortar color matching the units selected. Mortar color match to units are a provided by the manufacturer of ACMUs.
4. Size: 12" x 8" x 16" (nominal)
5. Type: RSC-RF SOUNDBLOX® as manufactured by Sound Seal.

6. Carefully prepared aggregate and shall meet the current ASTM C-90 or ASTM C-129 requirements as appropriate.
7. Molds shall be employed so all units have one end of the cavities tightly closed. Slots and edges shall be straight and clean.
8. Acoustical Fillers: ACMUs shall have noise attenuating, incombustible, fibrous filler elements as supplied by SOUND SEAL, or approved equal, cut accurately to size and installed in the ACMU's cavities at the ACMUs manufacturing plant. The fillers shall have metal septa facing laminated to one side of the fibrous material and shall be installed with the septa facing away from the slots
9. Sound Absorption shall be per ASTM C – 423, the Sound Absorption Coefficient (SAC) per Octave Band Center Frequency (Hz) shall be per the tables below:

HZ	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**NRC**
SAC	0.48	0.70	0.93	1.14	1.05	0.97	0.91	0.84	0.85

HZ	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**	**4000**	**NRC**
SAC	0.75	0.76	0.77	0.70	0.67	0.68	0.56	0.51	0.85

A. Metal Accessories:
   1. For interior walls and partitions, and as required to secure masonry to adjoining construction, the Contractor shall provide hot-dipped galvanized metal anchors, ties and reinforcements conforming to ASTM A153/A153M, Class B2 that are galvanized after cutting.
   2. For exterior walls, the Contractor shall provide Type 316 stainless steel for anchors, anchor slots, ties and horizontal reinforcement.

B. Deformed reinforcing bars shall conform to ASTM A615/A615M Grade 60.

C. Horizontal Joint Reinforcement: Horizontal reinforcing shall be 2 inches less in width than the actual thickness of the wall or partition in which it is to be placed.
   1. Solid interior or exterior masonry walls: Walls shall be reinforced horizontally with truss type, standard 9 gauge (.148-inch) by 9 gauge (.148- inch). Reinforcing shall be spaced at 16-inch centers vertically.
   2. Corners: Corners shall be reinforced with the same type as wall reinforcing, standard 9 gauge (.148 inch) by 9 gauge (.148-inch), spaced in the same course as the wall reinforcing.
   3. Intersections: Intersections between walls and partitions shall be reinforced horizontally with same type as wall reinforcing, standard 9 gauge (.148- inch) by 9 gauge (.148-inch), spaced in the same course as the wall reinforcing.

D. Rebar Positioners: The Contractor shall provide vertical and horizontal rebar positioners spaced at 48-inch centers maximum.

E. Dovetail Anchors: Dovetail anchors shall be 1/8-inch by 1-inch by 2-inch with 3/16-inch diameter wire.

F. Rigid Anchors: Rigid steel anchors shall be 1 inch wide (minimum), 3/16 inch thick, and 18 inches long between bent ends. Each end shall be bent down 3 inches (minimum) into mortar filled masonry cells.

G. Partition Top Anchors: provide stainless steel partition top anchors set into sash block and extend to bond beam. Partition top anchor rods shall be 12-inches long.

H. Column Anchors: Masonry shall be anchored to columns at 24-inch centers with stainless steel anchors.

I. Metal Fastenings: Bolts, metal wall plugs or other approved metal fastenings for securing items to masonry and elsewhere shall be provided and installed as necessary.

J. Mortar Materials: Mortar materials shall be in accordance with Section 04060 - Masonry Mortaring and Grouting.

PART 3 - EXECUTION

3.01 GENERAL

A. Build chases and recesses as shown or required by others. Provide not less than 8 inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

B. Leave openings for equipment, piping, ducts, and other items to be installed subsequent to starting of unit masonry construction. After installation of said items, complete unit masonry construction to match work immediately adjacent to openings.

C. Use full size units without cutting wherever possible. Provide special unit masonry shapes for all transitions and intersections. Do not field-cut special shapes from regular unit masonry shapes or substitute other alternatives for the use of special unit masonry shapes.

D. Build interior masonry walls, visible from both sides in the finished work, using two wythes of masonry unless noted otherwise in the Contract Documents. Filled ground face masonry units shall be continuous over the entire plan of the wall including walls which continue behind fixtures, equipment, furniture, lockers and similar items.

E. Environmental Conditions: Materials and surrounding air temperature shall be maintained at a minimum 50 degrees F prior to, during, and 72 hours after completion of masonry work. Masonry shall not be erected when the ambient temperature is below 32 degrees F with a rising or falling temperature, or when there is a probability of such a condition existing within 48 hours, unless special provisions are made for heating the materials and protecting the work from freezing. Work will not be permitted with or on

frozen materials. Use of masonry units having a film of frost on their surfaces will not be permitted.

F. Sample Panel: Masonry work shall not be started until the specified sample panel has been approved. The sample panel shall be used as a standard for comparison of masonry work. Sample panel shall be destroyed only after all masonry work has been completed and approved by the Engineer.

G. Protection: At all times, surfaces of masonry on which work is not being performed shall be protected. When rain or snow is imminent and work is discontinued, tops of exposed masonry walls and similar surfaces shall be covered with a strong waterproof membrane, well secured in place.

H. Coursing: Masonry walls shall be carried up level and plumb all around. Do not carry up one section of the walls in advance of the others, unless specifically approved. Heights of masonry shall be checked with an instrument at each floor, and at sills and heads of openings, to maintain the level of walls. Masonry courses shall be maintained to a uniform dimension. Vertical and horizontal joints shall be formed to a uniform thickness. Concrete masonry units shall be laid in running bond where concealed and a stacked bond where exposed, unless noted otherwise. Filled ground faced and acoustical units shall in stacked bond. One unit and one mortar joint shall be coursed to equal 8 inches. Mortar joints shall be tooled to be concave.

I. Placing and Bonding: Solid masonry units shall be placed in a full bed of mortar, with full head joints, and shall be uniformly jointed with other work.
   1. Mortar Removal: Excess mortar shall be removed as the installation progresses.
   2. Corners and Intersections: Intersections and external corners shall be interlocked. Horizontal reinforcing shall be spliced at intersections and corners with a 6-inch overlap of side rods.
   3. Adjustment: Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, mortar shall be removed and replaced with new mortar.
   4. Cutting: Job site cutting of exposed masonry units shall be performed with power masonry saws to provide straight, clean, unchipped edges. All glazed brick and glazed structural tile shall be cut using a continuous rim wet cutting diamond blade suitable for cutting these material types. Broken masonry unit corners or edges shall not be allowed.
   5. Flush Joints: Mortar joints shall be cut flush where ceramic wall tile is to be installed.
   6. Control Joints: Nonload-bearing masonry partitions shall be isolated from vertical and horizontal structural framing members with control joints.
   7. Placing Metalwork: Structural steelwork, bolts, anchors, inserts, plugs, ties, lintels and miscellaneous metalwork specified in other Sections, shall be placed and built into position as the installation progresses.
   8. Extent of Masonry: Masonry partitions and walls shall extend from the floor to the bottom of floor or roof construction above, unless otherwise indicated.

9. Bonding and Anchoring: Walls and partitions shall be structurally bonded or anchored to each other and to concrete walls, beams, columns, and wall and roof diaphragms. Nonload-bearing walls and partitions shall be anchored to construction above in a manner that provides appropriate lateral stability and vertical movement of floor and roof construction above.
10. Preparation for New Work: Unfinished masonry shall be stepped back for joining with new masonry. Toothing will not be permitted.

J. Horizontal Joint Reinforcement and Anchorages: Horizontal joint reinforcement and anchorages shall be constructed as follows:
   1. Reinforcement Spacing: Horizontal joint reinforcement shall be spaced at a minimum of 16 inches on center, measured vertically.
   2. Reinforcement Placing: Masonry joint reinforcement shall be placed in the first horizontal joint above and below openings. Reinforcement shall be extended a minimum of 16 inches on each side of openings. Joint reinforcement shall be placed continuously in the first joint below the top of all walls. Joint reinforcement ends shall be lapped a minimum of 6 inches. Joints at corners and intersections shall be reinforced with strap anchors at 16-inch centers.
   3. For parapets, space reinforcing at 8 inches on centers vertically
   4. Reinforce all walls with continuous horizontal joint reinforcement unless specifically noted or specified to be omitted.

K. Waterproofing Course: A waterproofing course of flashing as specified in Section 07620 shall be provided where shown, and at the following locations: at the bottom of masonry walls, at points where roofs adjoin exterior masonry walls, at lintels, below louver sills and window sills, and at other locations shown on the Contract Drawings.
   1. Surface Condition: Surfaces to receive waterproofing course shall be smooth, dry, and free from loose material before applying the waterproofing course.
   2. Application: Flashing shall project 1/4 inch from the outside face of the wall and shall be built into the walls as indicated. Flashing shall extend a minimum of 8 inches beyond the line of the jamb, with the ends turned up 2 inches to form a pan at the heads and sills of louver and window openings, and at the heads of door openings.
   3. Place through-wall flashing on bed of mortar and cover with mortar.
   4. Interlock metal 2- part and interlock overlap at seams as recommended by the manufacturer, but with minimum lap of 4 inches.

L. Control Joints: Preformed control joint material shall be installed in continuous lengths. Butt and corner joints shall be sealed in accordance with manufacturer's instructions. Control joints shall be sized as indicated on the Contract Drawings. Horizontal joint reinforcement shall not continue through control joints.

M. Built-In Work: Metal door and window frames, fabricated metal frames, louvered openings, anchor bolts, pipes, ducts, conduits, plates and items specified in other sections shall be built in as the work progresses. Items shall be built in plumb and level. Frame voids shall be filled solid with grout. Adjacent masonry cores shall be filled with

grout for a minimum of 12 inches beyond the framed openings. Do not build in organic materials subject to deterioration.

N. Tolerances: Masonry work shall meet the tolerances specified in ACI 530.1/ASCE 6-95/TMS 602.

O. Cutting and Fitting: Masonry shall be cut and fit for chases, pipes, conduit, sleeves, grounds, and other items specified elsewhere. The work shall be coordinated to provide correct size, shape, and location.

3.02 LAYING MASONRY WALLS, GENERAL

A. Mortar Types: Unless otherwise indicated, use mortar as specified in Section 04060, and as follows:
   1. Use Type S mortar for all wall types both interior and exterior exposure.
   2. Type N mortar will not be accepted for use on the project.
   3. Use grout fill for structural requirements and for grouting reinforcing steel in unit masonry construction.
   4. Do not use mortar which has begun to set or if more than 1/2 hour has elapsed since initial mixing. Retemper mortar during the 1/2-hour period only as required to restore workability.

B. Lay out walls in advance for accurate spacing of surface pattern bond with uniform joint widths and to properly locate openings, masonry control joints, returns and offsets. Avoid the use of less than half size units at corners, jambs and wherever possible at other locations.

C. Lay up walls plumb and true to comply with specified tolerances, with courses level, accurately spaced and coordinated with other work.

D. Lintels and Bond Beams:
   1. Provide galvanized steel lintels where shown and as specified in Section 05500.
   2. Provide masonry lintels and bond beams where shown at openings of 16 inches or more. Provide formed-in-place masonry lintels and bond beams. Temporarily support formed-in-place lintels and bond beams.
   3. Unless otherwise shown, provide one horizontal No. 6 deformed reinforcing bar for each 4 inches of wall thickness.
   4. For hollow masonry unit walls, use specially formed "U" shaped lintel and bond beam units with reinforcing bars placed as shown. Lintels and the course above all lintels shall be filled with grout.
   5. Bond beams for interior walls are to place every 14-feet vertical for 8- inch thick, 18-feet vertical for 10-inch thick and 24 feet vertical for 12- inch thick and, at the second course below the top of walls. Partition top anchors shall extend past top sash block to bond beam set at second course below top of walls.
   6. Bond beams shall be provided above and below all wall openings. Where lintels beams are required provide bond beam directly above the lintel.

7. Provide minimum bearing at each jamb, of 4 inches for openings less than 6 feet - 0 inches wide, and 8 inches for wider openings.
8. On concrete and clay unit masonry walls where pattern bond remains visually exposed, increase minimum bearing of masonry lintels to maintain continuity of joint pattern of wall and install so as to be indistinguishable from surrounding masonry.

E. Mortar Color and Texture:
   1. Lay all concrete unit masonry using mortar of natural color.
   2. Lay all filled ground face and acoustical concrete unit masonry work using mortar of natural color. Rake as specified to receive pointing mortar.

F. Hand select ground face masonry units to assure uniform continuity of finished surfaces from unit to unit. Glazed structural tile with misaligned face ceramic glazing shall be permanently removed from the Site.

G. Environmental Conditions:
   1. Site Facilities: Supplemental heat sources, as may be required should the Contractor wish to continue unit masonry construction in cold weather, are not available at the site. The provision and expense of all supplemental heat energy sources, fuel and equipment is the responsibility of the Contractor.

3.03 FILLED GROUND FACE CONCRETE MASONRY UNITS

A. Bond:
   1. Filled ground face concrete masonry units shall be laid in a stacked bond pattern. All vertical exterior corners are to be bullnose shape.
   2. Units shall be hand selected from the stock of more than one pallet at a time in order to help insure uniform distribution of possible color differences in material.
   3. Mortar joints in filled ground face concrete masonry units shall be raked back minimum of 1/4 inch, allowed to cure for 24 hours, and then shall be pointed using pointing mortar with waterproofing additive as specified in Section 04060.
   4. Apply a job site spray application of water based acrylic (TRENDCOAT (WB) or approved equal) to all ground faced block walls after erection and clean- down and when the walls are dry. Apply the acrylic evenly to cover the entire surface without forming drops or runs. Apply acrylic with airless spray equipment. Apply field coat of acrylic in compliance with manufacturer's limited warranty requirements or in place of job site spray apply waterproofing coating apply integral water resistive additive to mortar.

3.04 CONCRETE MASONRY UNITS

A. Bed and Head Joints: The first course of concrete masonry units shall be laid in a full bed of mortar for the full width of the unit. Bed joints of concrete masonry units shall be formed by applying the mortar to the entire top surfaces of the inner and outer face shells, and head joints shall be formed by applying the mortar for a width of about 1

inch to the ends of the adjoining units laid previously. Joints shall be mortared smooth, not furrowed, and of such thickness that mortar will be forced out of the joints as the units are being placed in position. Where anchors, bolts, reinforcing and ties occur within the cells of the units, such cells shall be filled solid with grout as the work progresses.

B. Concrete Brick: Concrete brick shall be used for topping out walls under sloping slabs, distributing concentrated loads, backing brick headers, and elsewhere as indicated.

C. Unit Condition: Concrete masonry units shall be placed dry with no previous wetting.

D. Bond: Concrete masonry units shall be laid in a running bond pattern with vertical joints aligned with joints in alternative courses above and below.

3.05 REINFORCED MASONRY

A. Setting Masonry: Masonry for vertically reinforced masonry units shall be laid with core cells vertically aligned. Core cells shall be clear of mortar and unobstructed. Mortar shall be placed in masonry unit bed joints and shall be back 1/4 inch from the edge of the unit grout spaces, and beveled back and upward. Mortar shall be cured 7 days before placing grout.

B. Reinforcing: Concrete masonry unit cores shall be reinforced with reinforcement bars and grout as shown. Vertical reinforcement shall be kept in position using rebar positioners at top and bottom of cells and at intervals not exceeding 48 inches. Reinforcement shall be spliced in accordance with ACI 530/ASCE 5- 95/TMS 402, but splice lap shall be not less than 24 bar diameters.

C. Grouting: Masonry unit surfaces in contact with grout shall be wetted just prior to grout placement. Spaces less than 2 inches in width shall be grouted with fine grout using low lift grouting techniques. Spaces 2 inches or greater in width shall be grouted with coarse grout using high or low lift grouting techniques. When grouting is stopped for more than one hour, grout shall be terminated 1-1/2 inches below top of upper masonry unit to form a positive key for subsequent grout placement.

D. Low Lift Grouting: The first lift of grout shall be placed to a height of 16 inches and then shall be rodded for grout consolidation. Subsequent lifts shall be placed in 8-inch increments and rodded for grout consolidation.

3.06 ACOUSTICAL MASONRY

A. General: The installation shall comply with the minimum requirements of the current Specification for Masonry Structures (TMS 602/ACI 530.1/ASCE 6).

B. ACMUs shall be laid in stacked bond with full face shell mortar bedding and 3/8” mortar joints.

C. Mortar joints shall be tooled, brushed, and finished-tooled.

D. The ACMU apertures shall be exposed to the area where the sound absorption is desired as indicated on the plans. Care shall be taken to ensure that the apertures are kept free of mortar or debris. Spray painting near the aperture openings shall not be allowed to prevent clogging of the fibrous inserts.

E. Coat unslotted side of ACMUs with two coats of Thoroseal, see Section 09900 - Painting

F. ACMUs shall be laid with vertical control joints consistent with NCMA recommendations. Horizontal wire reinforcing shall be installed at 16" on-center.

G. ACMUs shall be laid with all rear cavities fill solid with masonry grout or Type "N," "O," or "K" mortar.

3.07 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   1. Space reinforcement not more than 16 inches o.c.
   2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.08 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
   1. Provide an open space not less than 2 inches wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
   2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
   3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.09 CLEANING

A. General: After mortar has set, new masonry work shall be cleaned as follows:
   1. All masonry: All excess mortar and mortar smears shall be removed. Any defective mortar shall be removed and replaced, matching adjacent work. Nonmetallic tools shall be used in all cleaning operations.
   2. Concrete Masonry, Ground Face Concrete Masonry Units, and Acoustical Concrete Masonry Units: Units shall be washed with clean water and soap powder using soft fiber brushes.
   3. Concrete Masonry and Filled Ground Face Concrete Masonry: Areas to be cleaned shall be soaked with water, then scrubbed, followed by a rinse with clean water. Fiber brushes shall be used to apply the cleaning solution and to wash the blockwork. Do not allow the acid solution to come in contact with metalwork, blockwork and stonework below the area being cleaned shall be kept wet during the cleaning process. Cleaning product shall be Burnished Custom Masonry Cleaner (dilution 1 to 3) as manufactured by Sure Clean or approved equal

3.10 PROTECTION

A. Protection of Finished Work: Protective boards shall be provided at exposed external corners susceptible to damage by construction activities, without damaging completed work.

3.11 INSTALLATION

A. Repair remove and replace masonry units that are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point up all joints at corners, openings and adjacent work to provide a neat, uniform appearance, properly prepared for application of sealant compounds.

3.12 TABLE: 04100 MASONRY ACCESSORIES LISTING

04220 MASONRY ACCESSORIES LISTING		
MATERIALS	**LOCATION**	**DESCRIPTION**
#120 Horizontal Joint Reinforcement-Truss type (9 ga)	Solid interior and exterior masonry walls: single wythe interior walls with collar joints.	2-inches less in width than the actual thickness of the partition. Corners and intersections shall be reinforced with the same type as wall reinforcing

04220 MASONRY ACCESSORIES LISTING (continued)		
MATERIALS	**LOCATION**	**DESCRIPTION**
#Spyra-Lox Rebar-Joint Tie 9 ga. galvanized	For overlap and placement of rebars	Conform to overlap requirement Size ties to rebar size as to accommodate varying overlap requirements
#302W Column Web with Flexible Dovetail Attachment and #305 Dovetail (¼-inch)	Whenever masonry abuts structural walls or framework	7-inch long Anchor Strap and Column Web Tie that is 2- inches less than actual thickness of the partition
#302W Column Web Tie with #359FH Strap Ties (¼-inch)	Whenever masonry abuts existing steel columns and steel beam webs. Anchor Strap to be welded to steel.	7-inch long Anchor Strap and Column Web Tie that is 2- inches less than actual thickness of the partition
#PTA-310 - Partition Type Anchors	Anchorage to concrete slab and beams	Use with a sash block. Insert 12-inch long anchor to engage bond beam set below.
#PTA-420 - Partition Type Anchors	Anchorage to existing concrete slab and beams or steel beam flanges.	
#- RB &RB -Twin Re-Positioners, 9 ga Hot dipped galvanized	For all reinforcing place filled GFB or CMU cores.	Size according to masonry unit thickness
#- DW-10 HS Veneer Anchor	Anchorage of brick veneer to existing CMU	
#442 Type 316 Stainless Steel 12 ag Stone Anchor, Custom designed for CMU Soaps	CMU Soaps at tube steel lintel.	Contractor provided delegated design of custom anchor. Provide masonry clip at 32” on center with 0.157” power actuated fasteners. Predrilled holes to be 0.22” diameter.

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SECTION 05035

GALVANIZING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Where galvanizing is called for in the Contract Documents, the galvanizing shall be performed in accordance with the provisions of this Section unless otherwise noted.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Further requirements for galvanizing specific items may be included in other Sections of the Specifications. See section for the specific item in question.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Building Code of New York State
2. ASTM A123 Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
3. ASTM A143 Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
4. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
5. ASTM A384 Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
6. ASTM A385 Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
7. ASTM A780 Repair of Damaged Hot-Dip Galvanized Coatings
8. ASTM A924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
9. ASTM B 6 Specification for Zinc
10. ASTM D 6386 Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
11. ASTM E376 Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electcromagnetic) Test Methods

12. Federal Specification DOD-P-21035A

1.4 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.
   1. Certification that the item(s) are galvanized in accordance with the applicable ASTM standards specified herein. This certification may be included as part of any material certification that may be required by other Sections of the Specifications.

1.5 QUALITY ASSURANCE

A. Coating applicator shall specialize in hot-dip galvanizing after fabrication and follow the procedures in the Quality Assurance Manual of the American Galvanizers Association.

PART 2 -- PRODUCTS

2.1 COATING REQUIREMENTS

A. Material composition of the coating shall be in accordance with ASTM B6.

PART 3 -- EXECUTION

3.1 COATING APPLICATION

A. Clean all weld slag, rust, heat treating residue, and cutting oil from steel prior to galvanizing.

B. Products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strips, 1/8 inch thick and heavier which are to be galvanized shall be galvanized in accordance with ASTM A123. Products shall be fabricated into the largest unit which is practicable to galvanize before the galvanizing is done. Fabrication shall include all operations necessary to complete the unit such as shearing, cutting, punching, forming, drilling, milling, bending, and welding. Components of bolted or riveted assemblies shall be galvanized separately before assembly. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating. The galvanizer shall be a member of American Galvanizers Association.

C. Galvanize bolts, nuts, washers and hardware components in accordance with ASTM A153.

D. Sampling and testing of each lot shall be performed prior to shipment from the galvanizer's facility per ASTM A123.

E. Iron or steel sheets which are to be galvanized shall be galvanized in accordance with ASTM A924.

G. Protect products against embrittlement in conformance with ASTM A143.

H. Surface finish shall be continuous, adherent, smooth, and evenly distributed.

3.2 REPAIR OF GALVANIZING

A. Galvanized surfaces that are abraded or damaged at any time after the application of zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with 2 coats of zinc rich paint meeting the requirements of Federal Specification DOD-P-21035A and shall be thoroughly mixed prior to application. Zinc rich paint shall not be tinted. The total thickness of the 2 coats shall not be less than 6 mils. In lieu of repairing by painting with zinc rich paint, other methods of repairing galvanized surfaces in accordance with ASTM A780 may be used provided the proposed method is acceptable to the Engineer.

3.3 PAINTING GALVANIZED SURFACES

A. Galvanized surfaces that are to receive paint shall be cleaned and painted in accordance with Specification 09900, Painting.

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SECTION 05050

METAL FASTENING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05035 - Galvanizing

C. Section 05120 - Structural Steel Framing

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Building Code of New York State
2. AC 193 Acceptance Criteria for Mechanical Anchors in Concrete Elements
3. AC 308 Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
4. ACI 318 Building Code Requirements for Structural Concrete
5. ACI 355.2 Qualifications of Post-Installed Mechanical Anchors in Concrete
6. ACI 355.4 Qualifications of Post-Installed Adhesive Anchors in Concrete
7. AISC 348 The 2009 RCSC Specification for Structural Joints
8. AISC Code of Standard Practice
9. AWS D1.1 Structural Welding Code - Steel
10. AWS D1.2 Structural Welding Code - Aluminum
11. AWS D1.6 Structural Welding Code – Stainless Steel
12. Aluminum Association Specifications for Aluminum Structures

13. ASTM A572/A572M-94C Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50
14. ASTM A36 Standard Specification for Carbon Structural Steel
15. ASTM A325 Standard Specification for High-Strength Bolts for Structural Steel Joints
16. ASTM A489 Standard Specification for Eyebolts
17. ASTM A490 Standard Specification for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints
18. ASTM A563 Standard Specifications for Carbon and Alloy Steel Nuts
19. ASTM D1785 Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe
20. ASTM E488 Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
21. ASTM F436 Standard Specification for Hardened Steel Washers
22. ASTM F467 Standard Specification for Nonferrous Nuts for General Use
23. ASTM F593 Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs
24. ASTM F594 Standard Specification for Stainless Steel Nuts
25. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

1.4 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.
   1. Shop Drawings providing the fastener's manufacturer and type and certification of the fastener's material and capacity.
   2. Manufacturer’s installation instructions.
   3. Copy of valid certification for each person who is to perform field welding.
   4. Certified weld inspection reports, when required.
   5. Welding procedures.
   6. Installer qualifications.
   7. Certification of Installer Training.
   8. Inspection Reports.
   9. Results of Anchor Proof Testing.

1.5 QUALITY ASSURANCE

A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.

B. Installer Qualifications: Drilled-in anchors shall be installed by an Installer with at least three years of experience performing similar installations. Installer shall be certified as an Adhesive Anchor Installer in accordance with ACI-CRSI Adhesive Anchor Installation Certification Program.

C. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the Installer on the project. Training shall consist of a review of the complete installation process for drilled-in anchors, to include but not be limited to the following:
   1. Hole drilling procedure.
   2. Hole preparation and cleaning technique.
   3. Adhesive injection technique and dispenser training/maintenance.
   4. Rebar doweling preparation and installation.
   5. Proof loading/torquing.

D. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with AWS D1.2. All stainless steel welding shall be performed by welders certified in accordance with AWS D1.6. Certifications of field welders shall be submitted prior to performing any field welds.

E. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.

F. The Owner may engage an independent testing agency to perform testing of welded connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of the Engineer and/or an acceptable independent testing laboratory, at no additional cost to the Owner.

G. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Annex E of AWS D1.1 with relevant information presented.

PART 2 -- PRODUCTS

2.1 ANCHOR RODS (ANCHOR BOLTS)

A. Anchor rods shall conform to ASTM F1554 Grade 36 except where stainless steel or other approved anchor rods are shown on the Drawings. Anchor rods shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A.

B. Where anchor rods are used to anchor galvanized steel or are otherwise specified to be galvanized, anchor rods and nuts shall be hot-dip galvanized in accordance with ASTM F1554.

C. Where pipe sleeves around anchor rods are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

2.2 HIGH STRENGTH BOLTS

A. High strength bolts and associated nuts and washers shall be in accordance with ASTM A325 or ASTM A490. Bolts, nuts and washers shall meet the requirements of AISC 348 "The 2009 RCSC Specification for Structural Joints".

B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A325.

2.3 STAINLESS STEEL BOLTS

A. Stainless steel bolts shall conform to ASTM F-593. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.

B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer, and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts shall be of the same alloy as the bolts.

2.4 CONCRETE ANCHORS

A. General
   1. Where concrete anchors are called for on the Drawings, one of the types listed below shall be used; except, where one of the types listed below is specifically called for on the Drawings, only that type shall be used. The determination of anchors equivalent to those listed below shall be on the basis of test data performed by an approved independent testing laboratory. There are two types used:
      a. Expansion anchors shall be mechanical anchors of the wedge, sleeve, drop-in or undercut type.
      b. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete. Adhesive anchors shall be

two part injection type using the manufacturer's static mixing nozzle and shall be supplied as an entire system.

2. Expansion anchors shall not be used to hang items from above or in any other situations where direct tension forces are induced in anchor.
3. Unless otherwise noted, all concrete anchors which are submerged or are used in hanging items or have direct tension induced upon them, or which are subject to vibration from equipment such as pumps and generators, shall be adhesive anchors.
4. Adhesive anchors shall conform to the requirements of ACI 355.4 or alternately to AC 308. Expansion or mechanical anchors shall conform to the requirements of ACI 355.2 or alternately to AC 193. Anchors in Seismic Design Categories C through F shall conform to Building Code of New York State 1908.1.16, including, seismic test requirements, in accordance with ASTM E488.
5. Fire Resistance: All anchors installed within fire resistant construction shall either be enclosed in a fire resistant envelope, be protected by approved fire-resistive materials, be used to resist wind and earthquake loads only, or anchor non-structural elements.

B. Concrete Anchor Design:

An anchor design consists of specifying anchor size, quantity, spacing, edge distance and embedment to resist all applicable loads. Where an anchor design is indicated on the Drawings, it shall be considered an engineered design and anchors shall be installed to the prescribed size, spacing, embedment depth and edge distance. If all parts of an anchor design are provided on the Drawings except embedment depth, the anchors will be considered an engineered design and the Contractor shall provide the embedment depth as indicated in Paragraph B.3 unless otherwise directed by the Engineer. Where an anchor design is not indicated by the Engineer on the Drawings, the Contractor shall provide the anchor design per the requirements listed below.

1. Structural Anchors: All concrete anchors shall be considered structural anchors if they transmit load between structural elements; transmit load between non-structural components that make up a portion of the structure and structural elements; or transmit load between life-safety related attachments and structural elements. Examples of structural concrete anchors include but are not limited to column anchor bolts, anchors supporting non-structural walls, sprinkler piping support anchors, anchors supporting heavy, suspended piping or equipment, anchors supporting barrier rails, etc. For structural anchors, the Contractor shall submit an engineered design with signed and sealed calculations performed by an Engineer currently registered in the State of New York. Structural anchors shall be of a type recommended by the anchor manufacturer for use in cracked concrete and shall be designed by the Contractor in accordance with ACI 318 Appendix D.

2. Non-Structural Anchors: All other concrete anchors may be considered non-structural concrete anchors. The Contractor shall perform an engineered design for non-structural anchors. The Engineer may request the Contractor provide anchor design details for review, but submission of a signed, sealed design is not required. Non-structural anchors shall be designed by the contractor for use in uncracked concrete.
3. Minimum anchor embedment shall be as indicated on the Drawings or determined by the Contractor's engineered design. Concrete anchors shall be embedded no less than the manufacturer's standard embedment (expansion or mechanical anchors) or to provide a minimum allowable bond strength equal to the allowable yield capacity of the rod/bolt (adhesive anchors).

C. Structural Anchors:
   1. Mechanical Anchors:
      a. Wedge Anchors: Wedge anchors shall be "Kwik Bolt TZ" by Hilti, Inc., "TruBolt +" by ITW Redhead, "Strong-Bolt" or "Strong-Bolt 2" by Simpson Strong-Tie Co. or "Powerstud SD-1" or "Powerstud SD-2" by Powers Fasteners.
      b. Screw Anchors: Screw anchors shall be "Kwik HUS-EZ" and "KWIK HUS-EZ-I" by Hilti, Inc., "Titen HD" by Simpson Strong-Tie Co., or "Wedge-Bolt +" by Powers Fasteners. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.
      c. Sleeve Anchors: Sleeve anchors shall be "HSL-3 Heavy Duty Sleeve Anchor" by Hilti, Inc. or "Power-Bolt +" by Powers Fasteners.
      d. Undercut Anchors: Undercut anchors shall be "HDA Undercut Anchor" by Hilti, Inc., "Torq-Cut Undercut Anchor" by Simpson Strong-Tie Co., "Atomic + Undercut Anchor" by Powers Fasteners
   2. Adhesive Anchors:
      a. Adhesive anchors shall be "Epcon G5" by ITW Redhead, "HIT HY-150 Max SD" by Hilti, Inc., "SET-XP" by Simpson Strong-Tie Co., or "Powers 1000+" by Powers Fasteners.
      b. Structural adhesive anchor systems shall be IBC compliant and capable of resisting short term wind and seismic loads (Seismic Design Categories A through F) as well as long term and short term sustained static loads in both cracked and uncracked concrete in all Seismic Design Categories. Structural adhesive anchor systems shall comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**

D. Non-Structural Anchors: In addition to the acceptable non-structural anchors listed below, all structural anchors listed above may also be used as non-structural anchors.
   1. Mechanical Anchors:
      a. Wedge Anchors: Wedge anchors shall be "Kwik Bolt 3" by Hilti, Inc. or "TruBolt" by ITW Redhead.
      b. Screw Anchors: Screw anchors shall be "Kwik HUS" by Hilti, Inc., "Wedge-Bolt" by Powers Fasteners or "Large Diameter Tapcon (LDT) Anchor" by ITW Redhead. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.
      c. Sleeve Anchors: Sleeve anchors shall be "HSL Heavy Duty Sleeve Anchors" by Hilti, Inc. "Power-Bolt" by Powers Fasteners or "Dynabolt Sleeve Anchor" by ITW Redhead.
      d. Drop-In Anchors: Drop-in anchors shall be "Drop-In" by Simpson Strong-Tie Co., "HDI Drop-In Anchor" by Hilti, Inc. or "Multi-Set II Drop-In Anchor" by ITW Redhead.
      e. Undercut Anchors: Undercut anchors shall be "HDA Undercut Anchor" by Hilti, Inc.
   2. Adhesive Anchors:
      a. Adhesive anchors shall be "Epcon A7" or "Epcon C6" by ITW Redhead, "HIT HY-150 Max" by Hilti, Inc., "SET Epoxy Tie" or "AT" by Simpson Strong-Tie Co., or "Powers AC 100+ Gold" or "T308+ Epoxy" by Powers Fasteners.
      b. Non-structural adhesive anchors systems shall be IBC compliant and capable of resisting short term wind and seismic (Seismic Design Categories A and B) as well as long term and short term sustained static loads in uncracked concrete
      c. Non-structural adhesive anchor embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable yield capacity of the rod/bolt unless noted otherwise on the Drawings.
      d. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**

E. Concrete Anchor Rod/Bolt Materials:
   1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized unless otherwise indicated on the Drawings.
   2. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.

3. Nuts, washers, and other hardware shall be of a material to match the anchors.

2.5 MASONRY ANCHORS

A. Anchors for fastening to solid or grout-filled masonry shall be adhesive anchors as specified above for concrete anchors.

B. Anchors for fastening to hollow masonry or brick shall be adhesive anchors consisting of threaded rods or bolts anchored with an adhesive system dispensed into a screen tube inserted into the masonry. The adhesive system shall use a two-component adhesive mix and shall inject into the screen tube with a static mixing nozzle. Thoroughly clean drill holes of all debris and drill dust with nylon (not wire) brush prior to installation of adhesive and anchor. Contractor shall follow manufacturer's installation instructions. The adhesive system shall be "Epcon System A7 or C6" as manufactured by ITW Ramset/Redhead, "HIT HY-70 System" as manufactured by Hilti, Inc., "SET Epoxy-Tie" or "AT Acrylic-Tie" as manufactured by Simpson Strong-Tie Co., or "AC100+ Gold by Powers Fasteners.

C. Masonry anchors used to anchor steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, masonry anchors shall also be galvanized.

D. Masonry anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater anchors shall be Type 316 stainless steel.

2.6 WELDS

A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).

B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.

C. Electrodes for welding stainless steel and other metals shall comply with AWS D1.6.

2.7 WELDED STUD CONNECTORS

A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

2.8 EYEBOLTS

A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

2.9 HASTELLOY FASTENERS

A. Hastelloy fasteners and nuts shall be constructed of Hastelloy C-276.

2.10 ANTISEIZE LUBRICANT

A. Antiseize lubricant shall be C5-A Anti-Seize by Loctite Corporation, Molykote P-37 Anti-Seize Paste by Dow Corning, 3M Anti-Seize by 3M, or equal.

PART 3 -- EXECUTION

3.1 MEASUREMENTS

A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to the Engineer for clarification prior to starting fabrication.

3.02 ANCHOR INSTALLATION

A. Anchor Rods, Concrete Anchors, and Masonry Anchors
   1. Anchor rods shall be installed in accordance with AISC "Code of Standard Practice" by setting in concrete while it is being placed and positioned by means of a rigidly held template. Overhead adhesive anchors, and base plates or elements they are anchoring, shall be shored as required and securely held in place during anchor setting to prevent movement during anchor installation. Movement of anchors during curing is prohibited.
   2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.
   3. Concrete anchors shall not be used in place of anchor rods without Engineer's approval.
   4. All stainless steel threads shall be coated with antiseize lubricant.

B. High Strength Bolts
   1. All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". All bolted joints shall be Type

N, snug-tight, bearing connections in accordance with AISC Specifications unless noted otherwise on the Drawings.

C. Concrete Anchors
   1. Concrete at time of anchor installation shall be a minimum age of 21 days.
   2. Concrete anchors designed by the Contractor shall be classified as structural or non-structural based on the requirements indicated above.
   3. Concrete Anchor Testing:
      a. At all locations where concrete anchors meet the requirements for structural anchors at least 25 percent of all concrete anchors installed shall be proof tested to the value indicated on the Drawings, with a minimum of one tested anchor per anchor group. If no test value is indicated on the Drawings but the installed anchor meets the requirements for structural anchors, the Contractor shall notify the Engineer to allow verification of whether anchor load proof testing is required.
      b. Contractor shall submit a plan and schedule indicating locations of anchors to be tested, load test values and proposed anchor testing procedure (including a diagram of the testing equipment proposed for use) to the Engineer for review prior to conducting any testing. Testing of anchors shall be in accordance with ASTM E488 for the static tension test. If additional tests are required, inclusion of these tests shall be as stipulated on Contract Drawings.
      c. Where Contract Documents indicate anchorage design to be the Contractor's responsibility and the anchors are considered structural per the above criteria, the Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested and load test values, sealed by a Professional Engineer currently registered in the State of New York. The Contractor's Engineer shall also submit documentation indicating the Contractor's testing procedures have been reviewed and the proposed procedures are acceptable. Testing procedures shall be in accordance with ASTM E488.
      d. Concrete Anchors shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the anchor after loading shall be considered a failure. Anchors exhibiting damage shall be removed and replaced. If more than 5 percent of tested anchors fail, then 100 percent of anchors shall be proof tested.
      e. Proof testing of concrete anchors shall be performed by an independent testing laboratory hired directly by the Contractor and approved by the Engineer. The Contractor shall be responsible for costs of all testing, including additional testing required due to previously failed tests.

4. All concrete anchors shall be installed in strict conformance with the manufacturer's printed installation instructions. A representative of the manufacturer shall be on site when required by the Engineer.
5. All holes shall be drilled with a carbide bit unless otherwise recommended by the manufacturer. No cored holes shall be allowed unless specifically approved by the Engineer. If coring holes is allowed by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris and drill dust with compressed air followed by a wire brush prior to installation of adhesive and threaded rod/bolt unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Where depth of hole exceeds the length of the static mixing nozzle, a plastic extension hose shall be used to ensure proper adhesive injection from the back of the hole. Injection of adhesive into the hole shall utilize a piston plug to minimize the formation of air pockets. Wipe rod free from oil that may be present from shipping or handling.

D. Other Bolts
1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal.
2. All stainless steel bolts shall be coated with antiseize lubricant.

3.3 WELDING

A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.

B. Welded stud connectors shall be installed in accordance with AWS D1.1.

3.4 INSPECTION

A. High strength bolting will be visually inspected in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". Rejected bolts shall be either replaced or retightened as required.

B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.

C. Post-installed concrete anchors shall be inspected as required by ACI 318.

3.5 CUTTING OF EMBEDDED REBAR

A. The Contractor shall not cut embedded rebar cast into structural concrete during installation of post-installed fasteners without prior approval of the Engineer.

+ + END OF SECTION + +

SECTION 05051

ANCHOR SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install anchor systems.
   2. This Section includes all anchor systems required for the Work, but not specified under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before anchor systems Work.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 318, Building Code Requirements for Structural Concrete.
   2. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
   3. ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   4. ANSI B212.15, Cutting Tools - Carbide-tipped Masonry Drills And Blanks For Carbide-tipped Masonry Drills.
   5. ANSI/MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
   6. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   7. ASTM A276, Specification for Stainless Steel Bars and Shapes.
   8. ASTM A493, Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
   9. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   10. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   11. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   12. ASTM C307, Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
   13. ASTM C579, Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   14. ASTM C881/C881M, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   15. ASTM D695, Test Method for Compressive Properties of Rigid Plastics.
   16. ASTM D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   17. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
   18. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
   19. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   20. ASTM F594, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   21. ASTM F1554, Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
   22. FS A-A-1922A, Shield, Expansion (Caulking Anchors, Single Lead).
   23. FS A-A-1923A, Concrete Expansion Anchors.

24. FS A-A-1925A, Shield, Expansion (Nail Anchors).
25. FS A-A-55614, Shield, Expansion (non-drilling expansion anchors).
26. ICC-ES AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
27. ICC-ES AC58, Acceptance Criteria for Adhesive Anchors in Masonry Elements.
28. ICC-ES AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
29. ICC-ES AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
30. ISO 3506-1, Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners -- Part 1: Bolts, Screws and Studs.
31. NSF/ANSI 61, Drinking Water System Components – Health Effects.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory: Shall comply with ASTM E329 and shall be experienced in tension testing of post-installed anchoring systems.
   2. Post-installed Anchor Installer: Shall be experienced and trained by post-installed anchor system manufacturer in proper installation of manufacturer's products. Product installation training by distributors or manufacturer's representatives is unacceptable unless the person furnishing the training is qualified as a trainer by the anchor manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of all anchor systems products intended for use in the Work including product type, intended location in the Project, and embedded lengths.
   2. Product Data:
      a. Manufacturer's specifications, load tables, dimension diagrams, acceptable base material conditions, acceptable drilling methods, and acceptable bored hole conditions.
      b. When required by Engineer, copies of valid ICC ES reports that presents load-carrying capacities and installation requirements for anchor systems.
   3. Samples:
      a. Representative Samples of anchor systems proposed for use in the Work. Review will be for type and finish only. Compliance with all other requirements is Contractor's exclusive responsibility.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. For each type of anchor bolt or threaded rod, submit copies of laboratory test reports and other data required to demonstrate compliance with the Contract Documents.
         1) Reports shall demonstrate compliance with ductile steel element definition of ACI 350, Appendix D, Section D.1.
      b. Post-installed anchor system manufacturer's certification that installer received training in the proper installation of manufacturer's products required for the Work.
   2. Manufacturer's Instructions:
      a. Installation instructions for each anchor system product proposed for use, including bore hole cleaning procedures and adhesive injection, cure and gel time tables, and temperature ranges (storage, installation and in-service).
   3. Field Quality Control Submittals:
      a. Submit results of field quality control testing and inspections performed by testing laboratory.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
   1. Keep materials dry during delivery and storage.
   2. Store adhesive materials within manufacturer's recommended storage temperature range.
   3. Protect anchor systems from damage at the Site. Protect products from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:
   1. At locations where conditions dictate that Work specified in other Sections is to be of corrosion resistant materials, provide associated anchor systems of stainless steel materials, unless other corrosion-resistant anchor system material is specified. Provide anchor systems of stainless steel materials where stainless steel materials are required in the Contract Documents.
   2. Stainless Steel Nuts:
      a. For anchor bolts and adhesive anchors, provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts for stainless steel anchors used for anchoring equipment, gates, and weirs, and other locations, if any, where the attachment will require future removal for operation or maintenance. Provide lock washer or double nuts on each anchorage device provided for equipment, as required by equipment manufacturer.
      b. For other locations, provide for each anchorage device a nut as specified or as required by anchor manufacturer. When ASTM A194/A194M, Grade 8S (Nitronic 60) nuts are not required for anchor bolts and adhesive anchors as specified in this Section, provide anti-seizing compound where stainless steel rods are used with stainless steel nuts of the same type.
   3. Materials that can contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

B. Design Criteria
   1. Size, Length, and Load-carrying Capacity: Comply with the Contract Documents. When size, length or load-carrying capacity of anchor system is not otherwise shown or indicated, provide the following:
      a. Anchor Bolts: Provide size, length, and capacity required to carry design load based on values and requirements of Paragraph 3.2.A of this Section. For conditions outside limits of critical edge distance and spacing in Paragraph 3.2.A of this Section, minimum anchor bolt embedment as shown or indicated in Paragraph 3.2.A of this Section apply and capacity shall be based on requirements of Laws and Regulations, including applicable building codes.
      b. Adhesive Anchors, Expansion Anchors, or Concrete Inserts: Provide size, length, type, and capacity required to carry design load. Anchor capacity shall be based on the procedures required by the building code in effect at the Site. Where Evaluation Service Reports issued by the ICC Evaluation Service are required in this Section, anchor capacities shall be based on design procedure required in the applicable ICC Evaluation Service Report.
         1) General: Determine capacity considering reductions due to installation and inspection procedures, embedment length, strength of base fastening materials, spacing, and edge distance, as indicated in the manufacturer's design guidelines. For capacity determination, concrete shall be assumed to be in the cracked condition, unless calculations demonstrate that the anchor system will be installed

in an area that is not expected to crack under any and all conditions of design loading.

2) Concrete Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by Engineer, provide minimum embedment depth of the greater of the following: required to develop tensile strength of anchor, or a minimum embedment of 10 anchor diameters; and minimum anchor spacing and edge distance of 12 anchor diameters.

3) Concrete Masonry Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by Engineer, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.

4) Concrete Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by Engineer, provide minimum embedment depth of six anchor diameters, and minimum anchor spacing and edge distance of seven anchor diameters.

5) Concrete Masonry Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by Engineer, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.

6) Concrete Undercut Anchors: Unless otherwise shown or indicated in the Contract Documents, or approved by Engineer, provide minimum anchor spacing and edge distance as tabulated in anchor manufacturer's instructions.

2. Design Loads. Comply with the Contract Documents. When design load of supported material, equipment, or system is not otherwise shown or indicated, provide the following:
   a. Equipment Anchors: Use design load recommended by equipment manufacturer. When equipment can be filled with fluid, use loads that incorporate equipment load and load imposed by fluid.
   b. Pipe Hangers and Supports: Use full weight of pipe, and fluid contained in pipe that are tributary to the support plus the full weight of valves and accessories located between the hanger or support being anchored and the next hanger or support.
   c. Hangers and Supports for Electrical Systems, and HVAC, Plumbing, and Fire Suppression Systems and Piping: Use the full weight of supported system that is tributary to the support plus the full weight of accessories located between the hanger or support being anchored and the next hanger or support. When piping or equipment is to be filled with fluid, anchor systems shall be sized to support such loads in addition to the weight of the equipment, piping, or system, as applicable.
   d. Delegated Design: When anchor systems are used for supporting materials, equipment, or systems delegated to a design professional retained by Contractor, Subcontractor, or Supplier, provide anchor system suitable for loads indicated in delegated design documents and consistent with the design intent expressed in the Contract Documents.

C. Application:
   1. Anchor Bolts:
      a. Where anchor bolt is shown or indicated, use cast-in-place anchor bolt unless another anchor type is approved by Engineer.
      b. Provide anchor bolts as shown or indicated, or as required to secure structural element to appropriate anchor surface.
   2. Concrete Adhesive Anchors:
      a. Use where adhesive anchors are shown or indicated for installation in concrete.
      b. Suitable for use where subject to vibration.
      c. Suitable for use in exterior locations or locations subject to freezing.
      d. Suitable for use in submerged, intermittently submerged, or buried locations.
      e. Do not use in overhead applications, unless otherwise shown or approved by Engineer.
      f. Do not use for pipe hangers, unless otherwise shown or approved by Engineer.
   3. Grout-filled Concrete Masonry Adhesive Anchors:
      a. Use where adhesive anchors are shown or indicated for installation in grout-filled concrete masonry units.

b. Suitable for use where subject to vibration.
c. Suitable for use in exterior locations or locations subject to freezing.
d. Do not use for pipe hangers, unless otherwise shown or approved by Engineer.

4. Hollow Concrete Masonry Adhesive Anchors:
   a. Use where adhesive anchors are shown or indicated for installation in hollow concrete unit masonry.
   b. Suitable for use where subject to vibration.
   c. Suitable for use in exterior locations or locations subject to freezing.
   d. Do not use for pipe hangers, unless otherwise shown or approved by Engineer.
5. Concrete Wedge Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation in concrete.
   b. Do not use where subject to vibration.
   c. Do not use in exterior locations or locations subject to freezing.
   d. Do not use in submerged, intermittently submerged, or buried locations.
   e. Suitable for use in overhead applications.
6. Grout-filled Concrete Masonry Wedge Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation on the interior face of grout-filled unit masonry.
   b. Do not use where subject to vibration.
   c. Do not use in exterior locations or locations subject to freezing.
7. Hollow Concrete Masonry Sleeve Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation in hollow concrete unit masonry or solid brick.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use where subject to vibration.
   d. Do not use in exterior locations or locations subject to freezing.
8. Drop-in Expansion Anchors:
   a. Use drop-in expansion anchors installed in concrete where light-duty anchors are required to support piping or conduit two-inch diameter or smaller.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use where subject to vibration.
   d. Do not use at submerged, intermittently submerged, or buried locations.
   e. Do not use in exterior locations or locations subject to freezing.
   f. Suitable for use in overhead applications.
9. Concrete Undercut Anchors:
   a. Use where undercut anchors are shown or indicated for installation in concrete.
   b. Suitable for use where subject to vibration.
   c. Do not use in submerged, intermittently submerged, or buried locations.
   d. Do not use in exterior locations or locations subject to freezing.
   e. Suitable for use in overhead applications.
10. Concrete Inserts:
   a. Use only where shown or indicated in the Contract Documents.
   b. Allowed for use to support pipe hangers and pipe supports for pipe size and loading recommended by the concrete insert manufacturer.
11. Drive-In Expansion Anchors:
   a. Use drive-in expansion anchors installed in concrete, precast concrete, grouted masonry units, or brick, where light-duty anchors are required to support piping or conduit one-inch diameter and smaller.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use in overhead applications.
12. For Use in Precast Concrete Planks:

a. To support piping or conduit six-inch diameter and smaller, use low-profile drop-in anchors, hollow concrete masonry adhesive anchors, or through-bolts.
b. For piping greater than six-inch diameter, or to support safety-related systems, use through-bolts. Each through-bolt shall consist of threaded rod, nuts, washers, and bearing plate.

2.2 MATERIALS

A. Anchor Bolts:
1. Interior Dry Non-corrosive Locations: Provide straight threaded carbon steel rods complying with ASTM F1554, Grade 36, with heavy hex nuts complying with ASTM A563 Grade 36, unless otherwise shown or indicated on the Drawings. Hooked anchor bolts are unacceptable.
2. Exterior, Buried, Submerged Locations, or When Exposed to Wastewater: Provide stainless steel straight threaded rods complying with ASTM F593, AISI Type 316, Condition A, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required. Other AISI types may be used when approved by Engineer. Hooked bolts are unacceptable.
   a. Stainless steel straight threaded rod shall comply with ductility requirements of ACI 350 or ACI 318 Appendix D, Section D.3.3.
3. Equipment: Provide anchor bolts complying with material requirements of this Section and equipment manufacturer's requirements relative to size, embedment length, and anchor bolt projection. Anchor bolts shall be straight threaded rods with washers and nuts as specified in this Section. Hooked bolts are unacceptable.
4. Anchoring of Structural Elements: Provide anchor bolts of size, material, and strength shown or indicated in the Contract Documents.

B. Concrete Adhesive Anchors:
1. General:
   a. Adhesive anchors shall consist of threaded rods anchored into hardened concrete using an adhesive system.
2. Products and Manufacturers: Provide one of the following:
   a. HIT-RE 500-SD Injection Epoxy Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
   b. SET-XP Epoxy-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
   c. Or equal.
3. Adhesive:
   a. Adhesive system shall use two-component adhesive mix.
   b. Epoxy adhesives shall comply with physical requirements of ASTM C881/C881M, Type IV, Grade 2 and 3, Class A, B, and C, except gel times.
   c. Adhesives shall have a current evaluation report by ICC Evaluation Service for use in both cracked and uncracked concrete with seismic recognition for SDC A through F as tested and assessed in accordance with ICC-ES AC308.
   d. Adhesives shall have minimum bond strength and minimum design bond strength (bond strength multiplied by strength reduction factor) in accordance with Table 05051-A:

TABLE 05051-A:
ADHESIVE BOND STRENGTH [1,2]

Anchor	Uncracked Concrete		Cracked Concrete	
Rod Diameter / Dowel Size	Bond Strength (psi)	Design Bond Strength (psi)	Bond Strength (psi)	Design Bond Strength (psi)
3/8-inch / #3	2040	1300	1090	700
1/2-inch / #4	1920	1200	920	560
5/8-inch / #5	1830	1150	710	390
3/4-inch / #6	1760	1050	710	460
7/8inch / #7	1670	900	610	340
1-inch / #8	1650	1050	850	460
- / #9	1900	1000	800	400
1.25-inch/ #10	1580	1000	730	400

Table Notes:

1. Bond strengths listed for hammer-drilled, dry hole.
2. Bond strengths listed for maximum short term concrete temperature of 110 degrees F and maximum long term concrete temperature of 75 degrees F.
3. Anchor:
   a. Provide continuously-threaded, AISI Type 316 stainless steel adhesive anchor rod. Threaded rods shall comply with the concrete adhesive anchor manufacturer's specifications as included in the ICC Service Evaluation Report for the anchor submitted. Nuts shall have specified proof load stresses equal to or greater than the minimum tensile strength of the stainless steel threaded rod used. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.
   b. Stainless steel threaded rod shall comply with ductility requirements of ACI 350 or ACI 318 Appendix D, Section D.3.3.

C. Grout-filled Concrete Masonry Adhesive Anchors:
   1. General:
      a. Adhesive anchors shall consist of threaded rods anchored into grout-filled concrete block masonry using an adhesive system.
   2. Products and Manufacturers: Provide one of the following:
      a. HIT-HY 150 Max Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
      b. Acrylic-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Adhesive:
      a. Adhesive system shall use two-component adhesive mix.
   b. Acrylate hybrid adhesives shall comply with the following:
      1) ASTM C579 compressive strength greater than 7,252 psi, or ASTM D695 compressive yield strength greater than or equal to 10,210 psi.
      2) ASTM C307 modulus of elasticity greater than 507,000 psi or ASTM D695 compressive modulus of elasticity greater than 660,800 psi.
      c. Adhesives shall have current ICC Evaluation Service Report for use in grout-filled concrete masonry, tested and assessed in accordance with ICC-ES AC 58.
   4. Anchor:
      a. Provide stainless steel adhesive anchor rod complying with ASTM F593, AISI Type 316, Condition CW, with ASTM F594, AISI Type 316 stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.

D. Hollow Concrete Masonry Adhesive Anchors:
   1. General:

a. Adhesive anchors shall consist of threaded rods with a cylindrical mesh steel or plastic screen tube anchored into hollow concrete block masonry using an adhesive system.

2. Products and Manufacturers: Provide one of the following:
   a. HIT-HY 20 for Masonry Anchoring System, by Hilti Fastening Systems, Inc.
   b. Acrylic-Tie Anchoring Adhesive, by Simpson Strong-Tie Company, Inc.
   c. Or equal.
3. Adhesive:
   a. Adhesive system shall use two-component adhesive mix.
   b. Hybrid adhesives shall comply with the following:
      1) ASTM D695 compressive strength, greater than 7,410 psi.
      2) ASTM D790 modulus of elasticity: 0.33 x 10^6 psi or ASTM D695 compressive modulus of elasticity greater than 0.668 x10^6 psi.
   c. Adhesives shall have a current ICC Evaluation Service Report for use in hollow concrete masonry as tested and assessed in accordance with ICC-ES AC58.
4. Anchor:
   a. Provide stainless steel adhesive anchor rod complying with ASTM F593, AISI Type 316, Condition CW, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.
5. Mesh Screen Tube:
   a. Provide with mesh size, length, and diameter as specified by adhesive anchor manufacturer.
   b. Mesh shall be AISI 304 stainless steel.

E. Concrete Wedge Expansion Anchors:
1. General:
   a. Concrete wedge expansion anchors shall consist of stud, wedge, nut, and washer.
2. Products and Manufacturers: Provide one of the following:
   a. Kwik Bolt TZ Wedge Anchor, by Hilti Fastening Systems, Inc.
   b. Or equal.
3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Provide concrete wedge expansion anchors suitable for use in cracked and uncracked concrete in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete wedge anchors in accordance with ACI 355.2 prequalification tests.
4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide expansion anchors complete with nuts and washers, AISI Type 304 stainless steel anchor body, in accordance with ASTM A276 or ASTM A493.
6. Anchor shall comply with ductility requirements of ACI 350 or ACI 318 Appendix D, Section D.3.3.
7. Concrete wedge expansion anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete with seismic recognition in seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

F. Grout-filled Masonry Wedge Expansion Anchors:
1. General:
   a. Grout-filled masonry wedge expansion anchors shall each consist of stud, wedge, nut, and washer.
2. Product and Manufacturers: Provide one of the following:
   a. Kwik-Bolt 3 Expansion Anchors, by Hilti Fastening Systems, Inc.
   b. Wedge-All Wedge Anchors, by Simpson Strong-Tie Company, Inc.
   c. Or equal.
3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Anchors shall be non-bottom bearing type with single-piece steel expansion clip providing 360-degree contact with base material and shall not require oversized holes for installation.

4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide AISI Type 316 stainless steel anchor, complete with nut and washer, in accordance with ASTM A276 or ASTM A493.
6. Grout-filled masonry wedge expansion anchors shall have a current ICC Evaluation Service report for use in fully-grouted concrete masonry construction when tested and assessed in accordance with ICC-ES AC01.

G. Hollow Concrete Masonry Sleeve Expansion Anchors:
1. General:
   a. Sleeve expansion anchors shall each consist of an externally threaded stud with full length expanding sleeve.
2. Products and Manufacturers: Provide one of the following:
   a. HLC Sleeve Anchors, by Hilti Fastening Systems, Inc.
   b. Dynabolt Sleeve Anchors, by ITW Red Head.
   c. Or equal.
3. Anchors shall comply with physical requirements of FS A-A-1922A. Anchors shall be non-bottom bearing type with single-piece steel expansion sleeve providing 360-degree contact with base material, and shall not require oversized holes for installation.
4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide expansion anchors complete with nuts and washers, Type 304 stainless steel, in accordance with ASTM A276 or ASTM A493.

H. Drop-in Expansion Anchors:
1. General:
   a. Drop-in expansion anchors shall each consist of an internally threaded, deformation-controlled expansion anchor with pre-assembled expander plug.
2. Products and Manufacturers: Provide one of the following:
   a. HDI Drop-In Anchors, by Hilti Fastening Systems, Inc.
   b. Drop-In Anchor, by Simpson Strong-Tie Company, Inc.
   c. Or equal.
3. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633, complying with physical requirements of FS A-A-55614, Type I. Anchors shall be flush or shell type. Provide low-profile anchors for use in precast concrete planks.

I. Concrete Undercut Anchors:
1. General:
a. Each concrete undercut anchor shall consist of threaded stud, thick-walled expansion sleeve, expander coupler, and nut and washer. Anchors shall be pre-set type or through-set type, as shown on the Drawings.
2. Products and Manufacturers: Provide one of the following:
   a. HDA Undercut Anchor, by Hilti Fastening Systems, Inc.
   b. DUC Ductile Undercut Anchor, by USP Structural Connectors.
   c. Or equal
3. Provide concrete undercut expansion anchors in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete undercut anchors in accordance with ACI 355.2 prequalification tests.
   a. Anchor shall comply with ductility requirements of ACI 350 or ACI 318 Appendix D, Section D.3.3.
4. Installed anchor shall exhibit form fit between bearing elements and the undercut in the concrete.
5. Interior Dry Non-Corrosive Locations: Provide carbon steel anchors, complete with nuts and washers, zinc plated, in accordance with ASTM B633.

6. Other Locations: Provide stainless steel anchors, complete with nuts and washers, manufactured of AISI Type 316 stainless steel or materials complying with ISO 3506-1 and having corrosion resistance equivalent to AISI Type 316 stainless steel.
7. Concrete undercut anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete for seismic recognition for seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

J. Concrete Inserts:
1. Manufacturers: Provide products of one of the following:
a. Unistrut Corporation.
b. Cooper B-Line, Inc.
c. Anvil International, Inc.
d. Or equal.
2. Spot Concrete Inserts:
a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall comply with ANSI/MSS SP-58, malleable iron, Type 18. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Provide nuts compatible with insert and to suit threaded hanger rod sizes.
3. Continuous Concrete Inserts:
a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall be continuous type and shall be manufactured from minimum 12-gage cold-formed channel sections, complying with ASTM A1011/A1011M, stainless steel, Grade 33, complete with styrofoam inserts, end caps, and means for attaching to forms. Provide channel nuts compatible with insert suitable for threaded hanger rod sizes.
4. Provide inserts with plain finish.

K. Drive-In Expansion Anchors:
1. General:
a. Drive-In expansion anchors shall each consist of stainless steel drive pin and expanding alloy body.
2. Products and Manufacturers: Provide one of the following:
a. Metal HIT Anchor, by Hilti Fastening Systems, Inc.
b. Zinc Nailon Anchor, by Simpson Strong-Tie Company, Inc.
c. Or equal.
3. Provide Type 304 stainless steel drive pin with zinc alloy body. Anchor shall comply with physical requirements of FS A-A-1925A, Type 1.

L. Unless approved by Engineer, do not use power-actuated fasteners or other types of bolts and fasteners not specified in this Section.

M. Anti-Seizing Compound:
1. Products and Manufacturers: Provide one of the following:
a. Pure Nickel Never-Seez, by Bostik.
b. Nickel-Graf, by Anti-Seize Technology.
c. Or equal.
2. Provide pure nickel anti-seizing compound.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials will be installed and advise Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Anchor Bolts:
1. Provide anchor bolts as shown or indicated in the Contract Documents, or as required to secure structural element to the appropriate anchor surface.
2. Locate and accurately set anchor bolts using templates or other devices as required, prior to placing concrete. Wet setting of anchor bolts is unacceptable.
3. Protect threads and shank from damage during installation and subsequent construction operations.
4. Unless otherwise shown or approved by Engineer anchor bolts shall comply with Table 05051-B:

TABLE 05051-B:
SINGLE ANCHOR ALLOWABLE LOADS ON ANCHOR BOLTS [1]

Bolt Diameter (inch)	F1554 Grade 36 F593 Type 316, Condition A				F1554 Grade 55			
	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3,3] (lb)	Tension[3] (lb)	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3] (lb)	Tension[3] (lb)
1/2	6	9	947	1,815	8.5	12.75	1,245	2,393
5/8	7.5	11.25	1,508	2,895	10.5	15.75	1,980	3,810
3/4	9	13.5	2,231	4,290	13	19.5	2,933	5,640
7/8	10.5	15.75	3,080	5,918	15	22.5	4,050	7,793
1	12	18	4,040	7,770	17	25.5	5,318	10,088
1 1/8	13.5	20.25	5,090	9,789	19	28.5	8,930	12,435
1.1/4	15	22.5	6,463	12,429	21	31.5	8,505	15,030

Table Notes:
1. Table is based on ACI 318 and ACI 350, Appendix D, f'_c = 4000 psi. Table 05051-B is not applicable to anchor bolts embedded in grouted masonry.
2. Critical edge distance and spacing are indicated in the table. Capacity of anchor bolts for other combination of edge distances and spacing shall be evaluated in accordance with ACI 318 and ACI 350, Appendix D.
3. Values for shear and tension listed are not considered to act concurrently. Interaction of tension and shear will be evaluated by Engineer in accordance with ACI 318 and ACI 350, Appendix D.

B. Adhesive Anchors, Undercut Anchors, and Expansion Anchors – General:
1. Prior to drilling, locate existing reinforcing steel in vicinity of proposed holes. If reinforcing conflicts with proposed hole location, obtain Engineer's approval of alternate hole locations to avoid drilling through or damaging existing reinforcing bars.

C. Adhesive Anchors:
1. Comply with manufacturer's written installation instructions and the following.
2. Drill holes to adhesive system manufacturer's recommended drill bit diameter to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits that comply with the tolerances of ANSI B212.15. Core-drilled holes are unacceptable.
3. Before setting adhesive anchor, hole shall be made free of dust and debris by method recommended by adhesive anchor system manufacturer. Hole shall be brushed with adhesive system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed

air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.

4. Before injecting adhesive, obtain Engineer's concurrence that hole is dry and free of oil and other contaminants.
5. Prior to injecting adhesive into the drilled hole, dispense, to a location appropriate for such waste, an initial amount of adhesive from the mixing nozzle, until adhesive is uniform color.
6. Inject adhesive into hole through injection system-mixing nozzle and necessary extension tubes, placed to bottom of hole. Discharge end shall be withdrawn as adhesive is placed but kept immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during anchor placement.
7. Twist anchors during insertion into partially-filled hole to guarantee full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining Work that could place load on installed adhesive anchors. Do not begin adjoining Work until adhesive anchors are successfully tested or when allowed by Engineer.
9. Limitations:
    a. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with anchor systems manufacturer's requirements during installation and curing of adhesive anchor system.
    b. Oversized Holes: Advise Engineer immediately if size of drilled hole is larger than recommended by anchor system manufacturer. Cost of corrective measures, including but not limited to redesign of anchors due to decreased anchor capacities, shall be paid by Contractor.
    c. Embedment depths shall be based on installation in normal-weight concrete with compressive strength of 2,500 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.

D. Expansion Anchors:
1. Comply with expansion anchor manufacturer's written installation instructions and the following:
2. Drill holes using anchor system manufacturer's recommended drill bit diameter and to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances of ANSI B212.15. Core drilled holes are unacceptable.
3. Before installing anchor, hole shall be made free of dust and debris by method recommended by anchor system manufacturer. Hole shall be brushed with anchor system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
4. Before installing anchor, obtain Engineer's concurrence that hole is dry and free of oil and other contaminants.
5. Protect threads from damage during anchor installation. Drive anchors not less than four threads below surface of the attachment. Set anchors to anchor manufacturer's recommended torque using a torque wrench.

E. Concrete Undercut Anchors:
1. Comply with undercut anchor manufacturer's written installation instructions and the following.
2. Protect threads from damage during anchor installation.
3. Drill hole to anchor manufacturer's specified depth and diameter using a drill bit matched to the specific anchor.
4. Before setting the undercut anchor, hole shall be free of dust and debris using method recommended by undercut anchor system manufacturer. Hole shall be blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.

5. Insert the anchor by hand until anchor reaches bottom of hole.
6. Set anchor in accordance with manufacturer's instructions using anchor manufacturer's specified setting tool.
7. Verify that the setting mark is visible on the threaded rod above the sleeve.
8. Anchor shall be set to manufacturer's recommended torque, using a torque wrench.

F. Concrete Inserts:
1. Comply with concrete insert manufacturer's installation instructions.
2. Inserts shall be flush with slab bottom surface.
3. Protect embedded items from damage during concrete placing. Ensure that embedded items are securely fastened to prevent movement during concrete placing, and ensure that embedded items do fill with concrete during concrete placing.
4. Inserts intended for piping greater than four-inch diameter shall be provided with hooked rods attached to concrete reinforcing.

G. Anti-Seizing Compound:
1. Provide anti-seizing compound in accordance with anti-seizing compound manufacturer's installation instructions, at locations indicated in Paragraph 2.1.B of this Section.
2. Do not use anti-seizing compound at locations where anchor bolt or adhesive anchor will contact potable water or water that will be treated to become potable.

3.3 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.4 FIELD QUALITY CONTROL

A. Site Tests:
1. Owner Will employ testing agency to perform field quality tensile testing of production adhesive anchors at the Site, unless otherwise specified.
   a. Testing shall comply with ASTM E488.
   b. Test at least ten percent of all types of adhesive anchors. If one or more adhesive anchors fail the test, Contractor shall pay cost of testing, or at Engineer's option Contractor may arrange for testing paid by Contractor, for all adhesive anchors of same diameter and type installed on the same day as the failed anchor. If anchors installed on the same day as the failed anchor also fail the test, Engineer may require retesting of all anchors of the same diameter and type installed in the Work. Contractor shall be responsible for retesting costs.
   c. Engineer will direct which adhesive anchors are to be tested and indicate test load to be used
   d. Apply test loads with hydraulic ram.
   e. Displacement of post-installed anchors shall not exceed D/10, where D is nominal diameter of anchor being tested.
2. Mechanical Anchors:
   a. Responsibility:
      1) Owner Will employ testing agency to perform field quality control tensile testing of mechanical anchors at the Site.
      2) Contractor shall demonstrate competence in installing mechanical anchors by performing field quality control tests.
   b. Perform field quality control tests on test anchors at location directed by Engineer. Test anchors shall not be part of the finished Work.
   c. Test not less than one installation of each type of mechanical anchor used in the Work.
      1) Load each test anchor to failure.
      2) Testing shall comply with ASTM E488.
      3) Apply test loads with hydraulic ram.

d. Anchors that fail to reach the specified test load shall be considered as not passing the test and shall be re-tested at no additional cost to Owner.
e. Testing agency shall submit test results to Contractor and Engineer within 24 hours of completion of test.

3. Correct defective Work by removing and replacing or correcting, as directed by Engineer.
4. Contractor shall pay for all corrections and subsequent testing required to confirm competence in the installation of post-installed mechanical anchors.
5. Testing agency shall submit test results to Contractor and Engineer within 24 hours of completion of test.

B. Manufacturer's Services:
1. Provide at the Site services of qualified adhesive manufacturer's representative during initial installation of adhesive anchor systems to train Contractor's personnel in proper installation procedures. Manufacturer's representative shall observe to confirm that installer demonstrates proper installation procedures for adhesive anchors and adhesive material.

+ + END OF SECTION + +

SECTION 05120

STRUCTURAL STEEL FRAMING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. Contractor shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install structural steel framing, including surface preparation and shop priming.

2. Structural steel framing is the Work defined in AISC 303, Section 2, and as shown or indicated in the Contract Documents. The Work also includes:

a. Providing openings in and attachments to structural steel framing to accommodate the Work under this and other Sections, and providing for structural steel framing items such as anchorage devices, studs, and all items required for which provision is not specifically included under other Sections.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before structural steel framing work.

C. Related Sections:

1. Section 03600, Grouting.

2. Section 05010, Metal Materials.

3. Section 05035, Galvanizing.

4. Section 05050, Metal Fastening.

2. Section 05051, Anchor Systems.

3. Section 09900, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. AISC 303, Code of Standard Practice for Steel Buildings and Bridges.
2. AISC 325, Steel Construction Manual.
3. AISC 360, Specification for Structural Steel Buildings.
4. ASME B46.1, Surface Texture (Surface Roughness, Waviness and Lay).
5. ASTM A6/A6M, Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
6. ASTM A36/A36M, Specification for Carbon Structural Steel.
7. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
8. ASTM A108, Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
9. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
10. ASTM A325, Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength.
11. ASTM A490, Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
12. ASTM A500/A500M, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
14. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
15. ASTM A992/A992M, Specification for Structural Steel Shapes.
16. ASTM E329, for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.
17. ASTM F436, Specification for Hardened Steel Washers.

18. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

19. ASTM F959, Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.

20 ASTM F1852, Specification for "Twist off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

21. AWS D1.1/D1.1M, Structural Welding Code-Steel.

22. CMAA 74, Specifications for Top Running & Under Running Single Girder Electric Traveling Cranes Utilizing Under Running Trolley Hoist.

23. ISO 2859-1, Sampling Procedures for Inspection by Attributes -- Part 1: Sampling Schemes Indexed by Acceptance Quality Limit (AQL) for Lot-by-Lot Inspection.

24. ISO 4017, Hexagon Head Screws -- Product Grades A and B.

25. RCSC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Steel Fabricator:

a. Structural steel fabricating plant shall possess current certificate from AISC stating that the fabrication facility complies with requirements for certification of "Standard for Steel Building Structures (STD)" of AISC's quality certification program. Fabricating plant shall maintain this certification throughout time of fabrication for this Project.

2. Welders and Welding Processes:

a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, Section 5, Qualification.

b. Each welder employed on or to be employed for the Work shall possess current AWS certification in the welding process with which welder will be working. Certifications shall be current and valid throughout the Work.

3. Surveyor:

a. Engage a registered professional land surveyor legally qualified to practice in the same jurisdiction as the Site, and experienced in providing surveying services of the kind indicated.

b. Responsibilities include but are not necessarily limited to:

1) Performing or supervising performance of field survey work to check lines and elevations of concrete and masonry bearing surfaces, and locations of anchorage devices and similar devices, before steel erection proceeds.

2) Notifying Contractor and Engineer in writing when surveyed Work does not comply with the Contract Documents.

3) Submit to Contractor field survey reports.

4. Testing Laboratory:

a. Owner shall retain the services of an independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials specified in this Section.

b. Laboratory shall comply with ASTM E329.

c. Testing laboratory shall be experienced in the types of testing required.

d. Welding inspection and welding inspector qualifications shall be in accordance with AWS D1.1/D1.1M

e. Selection of testing laboratory is subject to Engineer's acceptance

B. Quality of Product:

Shop inspection may be required by the Owner at his own expense. The Contractor shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Contractor shall furnish

all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under this Specification.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

   a. Complete details and schedules for fabrication and shop assembly of members and details, schedules, procedures, and diagrams showing proposed sequence of erection. Shop Drawings shall not be reproductions of Contract Drawings.

   b. Include complete information for fabrication of the structure's components, including but not limited to location, type, and size of bolts, details of blocks, copes and cuts, connections, camber, holes, member sizes and lengths, and other pertinent data. Clearly indicate welds using standard AWS notations and symbols, and clearly show or indicate size, length, and type of each weld.

   c. Setting drawings, templates, and directions for installing anchorage devices.

2. Product Data:

   a. Certified Mill Test Reports.

   b. Affidavit of Compliance with grade specified.

   c. Manufacturer's specifications and installation instructions for products listed below.

      1) High-strength bolts of each type, including nuts and washers.

      2) Welding electrodes and rods.

3) Load indicator bolts and washers.

d. Hollow structural section cavity connector manufacturer specifications, load tables, dimension diagrams, and acceptable base material conditions. Clearly indicate allowable strength design safety factors when ultimate load carrying capacities are submitted for approval.

e. Structural Steel Survey.

3. Samples:

a. Representative Samples of hollow section steel cavity connectors proposed for use. Review will be for type and finish only. Compliance with other requirements is Contractor's responsibility.

B. Informational Submittals: Submit the following:

1. Certificates.

a. Fabricator's AISC quality certification.

b. Welders' certifications.

c. Certified reports of laboratory tests on previously-manufactured, identical materials, and other data as necessary, to demonstrate compliance with the Contract Documents for the materials listed below:

1) Structural steel of each type, including certified mill reports indicating chemical and physical properties.

2) High-strength bolts of each type, including nuts and washers.

2. Supplier Instructions:

a. Installation data, handling, and storage instructions.

3. Source Quality Control Submittals:

a. When performed or when required by Engineer, submit results of source quality control testing and inspections performed at the mill or shop.

4. Field Quality Control Submittals:

    a. Written field survey reports for all bearing surfaces surveyed, verifying tolerance requirements, areas out of tolerance, and corrective measures required.

5. Qualifications Statements.

    a. Land surveyor.

    b. Testing laboratory.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage:

1. Protect steel members and packaged materials from corrosion and deterioration.

2. Do not store materials in or on the building or structure in manner that may cause distortion or damage to structural steel members, building, or supporting structures.

3. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Steel Types:

1. W-Shapes: ASTM A992/A992M.

2. C and MC Channels: ASTM A572/A572M, Grade 50.

3. Hollow Structural Sections: ASTM A500/A500M, Grade B

4. Angles, Plates, and Bars: ASTM A36/A36M.

5. Steel Pipe: ASTM A53/A53M, Grade B.

B. Anchorages, Fasteners, and Connectors:

1. Anchorage Devices: Refer to Section 05051, Anchor Systems.

2. High-Strength Threaded Fasteners: Heavy hexagonal structural bolts, heavy hexagon nuts, and hardened washers, as follows:

   a. Unless otherwise indicated, fasteners shall be quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A325, Type I, nuts complying with ASTM A563C, A563DH or A194/A194M 2H, and hardened washers complying with ASTM F436. Bolts, nuts and washers shall be hot-dip galvanized where shown or indicated.

   b. Use quenched and tempered alloy steel bolts, nuts and washers, complying with ASTM A490, only at locations where shown or indicated in the Contract Documents. ASTM A490 bolts shall not be galvanized.

   c. Tension control bolts, when used, shall comply with ASTM F1852.

   d. Compressible washer-type direct-tension indicators, when used, shall comply with ASTM F959, Type 325.

3. Threaded Rod: Provide threaded rods with heavy hexagon nuts, and hardened washers, as follows:

   a. Interior and Dry Locations: Provide threaded carbon steel rods complying with ASTM A36, with heavy hex nuts complying with ASTM A563A, unless otherwise shown or indicated on the Drawings.

   b. Exterior, Buried, or Submerged Locations, or When Exposed to Wastewater: Provide stainless steel threaded rods complete with washers complying with ASTM F593, AISI Type 316, Condition A, with ASTM A194/A194M, Grade 8S (nitronic 60) stainless steel nuts. Other AISI types may be used when approved by Engineer.

C. Electrodes for Welding: E70XX complying with AWS D1.1/D1.1M.

2.2 FABRICATION

A. Shop Fabrication and Assembly:

1. General:

a. Fabricate and assemble structural assemblies in the shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC 325, the Contract Documents, and as shown on approved Shop Drawings. Provide camber in structural members as shown or indicated.

b. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize handling of materials for storage and minimize handling at the Site.

c. Where finishing is required, complete the assembly, including welding of units, before commencing finishing operations. Provide finish surfaces of members exposed-to-view in the completed Work that are free of markings, burrs, and other defects.

B. Connections:

1. Shop Connections:

a. Unless otherwise shown or indicated, shop connections may be welded or high-strength bolted connections. Welds shall be 3/16-inch minimum.

b. Where reaction values of beam are not shown or indicated, connections shall be detailed to support one-half the total uniform load capacity tabulated in tables contained in AISC 325 for allowable loads on beams for the associated shape, span, and steel specified for the beam.

c. Shop-welded connections shall be detailed to eliminate or minimize eccentricity in the connection.

d. End-connection angles fastened to webs of beams and girders, and the thickness of angles, size, and extent of fasteners or shop welds, shall comply with tables of "Framed Beam Connections" in AISC 325. Connections shall be two-sided, unless otherwise shown or indicated.

2. Field Connections:

a. Field connections, unless otherwise shown or indicated, shall be made with high-strength bolts, and shall be bearing-type connections.

b. Use field welding only where shown or indicated or where approved by Engineer.

3. High-Strength Bolted Construction:

   a. Provide high-strength threaded fasteners in accordance with RCSC Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.

   b. High-strength bolt design shear values shall be as specified in AISC 325 for bolts with threads in the shear plane for bearing type connections, or as specified in this Section for slip-critical connections.

   c. Bolted connections shown or indicated as "SC" shall comply with slip-critical connection requirements in RCSC Specifications for Structural Joints Using ASTM A325 or ASTM A490 Bolts.

      1) Faying surfaces shall have a Class A surface condition.

      2) Slip-critical bolts shall be fully pre-tensioned to 70 percent of minimum specified tensile strength of the bolt using one of the following methods:

         a) Turn of nut with matchmarking.

         b) Twist-off tension control bolt (ASTM F1852).

         c) Direct tension indicator washer (ASTM F959).

         d) Minimum bolt diameter shall be 3/4-inch, unless otherwise shown or indicated.

4. Welded Construction: Comply with AWS D1.1/D1.1M for procedures, appearance, and quality of welds, and methods used in correcting defective welding Work.

   a. Assemble and weld built-up sections by methods that produce true alignment of axes without warp.

5. Where rigid connections are required by stresses shown or indicated, provide web shear reinforcement and stiffeners in accordance with AISC 360.

6. Moment connections shown but not detailed on the Drawings shall be detailed for bending moments and shears indicated on the Drawings.

C. Bracing:

1. Bracing for which stress is not shown or indicated shall have minimum two-bolt connection, or shop-welded connection of equivalent strength.

2. Vertical bracing and knee braces connecting to columns shall be on the centerline of columns, unless otherwise shown or indicated.

3. Knee braces shall be at 45-degree angle, unless otherwise shown or indicated.

4. Gussets shall be not less than 3/8-inch thick, unless otherwise shown or indicated.

D. Columns: Column shafts shall have finished bearing surface roughness not greater than 500 micro-inch in accordance with ASME B46.1, and ends shall be square within tolerances for milled ends in accordance with ASTM A6/A6M at the base and at splice lines.

E. Structural Tubing: Properly seal structural tubing to protect internal surfaces.

F. Holes and Appurtenances for Other Work:

1. Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on the approved Shop Drawings. If large block-outs are required and approved, reinforce the webs to develop specified shears. Provide threaded nuts welded to framing and other specialty items as shown or indicated to receive other work.

2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

2.3 FINISHING

A. Surface Preparation and Shop Priming: Structural steel shall be hot dipped galvanized as per the requirements of specification Section 05035, unless noted

otherwise. All galvanized steel to receive a finished coat shall be field prepped, primed and coated in conformation with specification Section 09900.

2.4 SOURCE QUALITY CONTROL

A. Inspection and Testing at the Mill or Shop:

1. Perform fabricator's standard procedures for source quality control, including inspections and testing.

2. Materials and fabrication procedures shall be subject to inspection and tests in mill and shop, conducted by a qualified inspection laboratory. Such inspections and tests do not relieve Contractor of responsibility for providing the Work in accordance with the Contract Documents.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which the Work will be performed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 ERECTION

A. General: Comply with AISC 303, AISC 360, and the Contract Documents.

B. Checking of Lines and Elevations: Before proceeding with structural steel erection, furnish services of a qualified surveyor to check lines and elevations of concrete and masonry bearing surfaces, and locations of anchorage devices and similar devices. Immediately report discrepancies to Engineer. Do not proceed with erection until defective Work that will support structural steel is corrected, including agreeing with Engineer upon compensating adjustments (if any) to structural steel Work.

C. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy-lines to achieve proper alignment of structures as erection proceeds.

D. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete the Work. Provide sufficient planking to comply with Laws and Regulations, and provide tightly-planked substantial floor within two stories or 30 feet, whichever is less, below each tier of steel beams on which work is performed.

E. Anchorage Devices:

1. Provide anchorage devices, including anchor bolts, and other connectors required for securing structural steel to foundations and other in-place construction.

2. Provide templates and other devices necessary for presetting anchorage devices to accurate locations.

3. Refer to Section 05051, Anchor Systems, for anchorage requirements.

F. Setting Bases and Bearing Plates:

1. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.

2. Set loose and attached base plates and bearing plates for structural members on steel wedges or other adjusting devices.

3. Tighten anchorage devices after supported members are positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.

4. Place grout between bearing surfaces and bases or plates in accordance with Section 03600, Grouting. Finish exposed surfaces, protect installed materials, and allow to cure in accordance with grout manufacturer's instructions, and as otherwise required. Bearing surfaces and other surfaces with will be in permanent contact shall be cleaned before assembly.

5. No cutting of structural steel members in the field will be allowed except by the written approval of the Engineer.

6. Do not use leveling plates or wood wedges.

G. Field Assembly:

1. Set structural frames accurately to the lines and elevations shown and indicated. Align and adjust the various members forming part of a complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

2. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.

3. Level and plumb individual members of structure within tolerances as specified in AISC 325. For members requiring accurate alignment, provide clip angles, lintels, and other members, with slotted holes for horizontal adjustment at least 3/8-inch in each direction, or more when required.

4. Splice members only where shown or indicated.

5. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05050, Metal Fastening.

H. Erection Bolts: On exposed-to-view, welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.

I. Connections:

1. All bolted connections shall use high strength bolts in accordance with Section 05050, Metal Fastening. High strength bolts shall be installed in accordance with AISC 348 “The 2009 RCSC Specification for Structural Joints”. Bolts specified or noted on the Drawings to be a tension or slip critical “SC” type connection shall be fully pretensioned with proper preparation of the faying surfaces. All other bolts shall be snug tightened unless otherwise noted on the Drawings.

2. Comply with AISC 325 for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds.

3. Do not enlarge inadequate holes in members by burning or by using drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

4. Hollow Structural Section Cavity Connectors:

    a. Comply with manufacturer's written installation instructions and the following.

    b. Cavity Connectors shall be torqued in accordance with manufacturer's instructions.

5. Misfits at Bolted Connections

    a. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

    b. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.

    c. Where misalignment between anchor rods and rod holes in steel members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.

J. Gas Cutting: Do not use gas-cutting torches for correcting fabrication defects in structural framing. Cutting will be allowed only on secondary members that are not under stress, as approved by Engineer. Finish gas-cut sections equal to a sheared appearance, when allowed.

K. Crane Runways:

1. Provide crane stops and other required items. Set runway girders straight and level, and to tolerances specified in CMAA 74.

L. Touch-up Painting:

1. Unless otherwise specified, comply with touch-up painting requirements in Section 09900, Painting.

2. Immediately after erection, clean field welds, bolted connections, and damaged or abraded areas of shop-applied paint. Apply paint to exposed areas with the same paint or coating material applied in the shop. Apply by brush or spray to provide not less than the dry film thickness specified in Section 09900, Painting.

3. Concrete Encased Steel: Steel members which will be encased in concrete shall be cleaned but not painted prior to encasement.

4. Contact Surfaces: Contact surfaces such as at field connections, shall be cleaned and primed but not painted.

5. Finished Surfaces: Machine finished surfaces shall be protected against corrosion by a rust-inhibiting coating which is easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

6. Surfaces Adjacent to Field Welds: Surfaces within 2 inches of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.3 FIELD QUALITY CONTROL

A. Site Tests and Inspections: Materials and erection procedures shall be subject to inspection and tests at the Site conducted by qualified inspection laboratory. Such inspections and tests do not relieve Contractor of responsibility for providing the Work in accordance with the Contract Documents.

1. Owner will engage independent testing and inspection laboratory to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.

a. Testing laboratory shall conduct and interpret tests, prepare and state in each report of results whether test specimens comply with the Contract Documents and specifically indicate all deviations.

b. High-strength Bolted Connections: Each high-strength bolted connection shall be visually inspected. Inspection shall identify

whether the Work complies with Sections 2, 3, and 8 of RCSC Specifications for Structural Joints Using ASTM A325 or A490 Bolts.

1) For connections that are slip-critical or subject to axial tension, inspector shall verify proper pre-tensioning.

2) For connections that are not slip critical and not subject to direct tension, bolt does not need to be inspected for bolt tension, but shall be visually inspected to verify that plies of connected elements are in snug contact.

3) Where bolts or connections are defective, correct defective workmanship, remove and replace, or correct as required defective bolts and connections. Contractor shall pay for correcting defective Work and tests required to confirm integrity of corrected Work.

c. Welds: Each weld shall be visually inspected.

1) Where visually defective welds are evident, further test welds using non-destructive methods. If welds are determined to be acceptable, Owner will pay for non-destructive testing. When welds are defective, Contractor shall pay for non-destructive testing.

2) Correct, or remove and replace, defective Work as directed by Engineer.

3) Contractor shall pay for corrections and subsequent tests required to determine weld compliance with the Contract Documents.

+ + END OF SECTION + +

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SECTION 05300

METAL DECKING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, equipment, materials and services to install all metal deck complete with all accessories for a complete installation in accordance with the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05035 - Galvanizing

C. Section 05050 - Metal Fastening

D. Section 05120 - Structural Steel Framing

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. AISI - Specification for the Design of Cold-Formed Steel Structural Members

B. SDI - Design Manual for Floor Decks and Roof Decks and Manual of Construction with Steel Deck.

C. ASTM Standards for Test Methods.

1.4 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.
   1. Complete layout and installation drawings and schedules with clearly marked dimensions.
   2. Detail and location drawings for all framing, supports, type and location of all welds and fasteners.
   3. Details of all accessories showing welding washers, pour stops, girder fillers, column closures, Z closures, cell closures, and all other required accessories.
   4. Manufacturer's design calculations or published literature for the structural properties of the metal decking.
   5. Qualifications of welders.

1.5 QUALITY ASSURANCE

A. All materials, workmanship and production methods shall be in accordance with SDI.

B. Manufacturer shall be regularly engaged in the manufacture of metal decking.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Steel sheet shall be flat rolled carbon steel sheets meeting the requirements of ASTM A653 Grade SQ33 or higher.

B. Steel shall be G-90 galvanized in accordance with Section 05035, Galvanizing.

C. For metal deck requiring painting, prior to field painting, deck shall be prime-painted in factory after galvanization.

D. Mechanical fasteners used for sidelap connections shall be SDI standard.

2.2 MANUFACTURERS

A. Vulcraft, Inc.

B. Or approved equal.

PART 3 -- EXECUTION

3.1 FABRICATION AND DESIGN

A. Design, fabrication and erection of decking shall comply with references listed in Section 1.03 and manufacturer's recommendations.

B. Deck units shall conform to the SDI standard type and gage shown on the Drawings.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be delivered in unbroken, undamaged, original packages bearing manufacturer's labels.

B. Metal decking shall be stored off the ground with one end elevated for drainage and covered with water-proof material in accordance with decking manufacturer's recommendations.

C. Decking shall be handled so as to preclude damage from any source.

D. Metal decking units may not be used for any purpose (such as scaffold decking) prior to incorporation in the work. Any units which have been so used will be rejected.

3.3 INSPECTION

A. Verify correct layout and alignment of supporting members and clean all support surfaces of debris. All defects shall be corrected prior to installation of metal decking.

3.4 INSTALLATION

A. Install deck units and accessories in accordance with shop drawings and manufacturer's recommendations. Deck units shall be installed where called for on the Drawings.

B. Position deck units on supporting steel framework and adjust to final position with ends bearing on supporting members and accurately aligned end to end before being permanently fastened. Extend deck units over three or more supports unless shown otherwise on the Drawings. Lap ends not less than 2 inches. Stagger end joints of adjacent deck units. Place deck units flat and square, secured to adjacent framing without warp or deflection.

C. Secure deck units to supporting members as shown on the Drawings. Weld pattern shall be as indicated on the Drawings in accordance with SDI. The Contractor may use an equivalent pattern of mechanical fasteners in lieu of welded fastening.

D. Attach deck at sidelaps with screws as indicated on the Drawings or as recommended by the manufacturer.

E. Cut and fit deck units around openings. Deck manufacturer shall approve openings larger than 6" diameter prior to cutting.

3.5 REPAIR OF GALVANIZING

A. Galvanizing shall be repaired at all welds, scarred areas, and rust spots in accordance with Section 05035, Galvanizing.

3.6 CONSTRUCTION GUIDELINES

A. Do not use deck units as a working platform or storage area until units are permanently attached in position.

B. Construction loads shall not exceed the load carrying capacity of the deck.

C. All units damaged during construction shall be repaired or replaced by the Contractor.

+ + END OF SECTION + +

SECTION 05400

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Soffit framing.
   2. Roof framing.
   3. Rigid furring channels.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of cold-formed steel framing product and accessory.

B. Shop Drawings:
   1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
   2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
   3. The design of the cold-formed steel framing shall be the responsibility of the contractor's fabricator. The sizes (depth) of the steel studs shall be as shown on the contract drawings. Unless specifically indicated on the construction documents, it shall be the responsibility of the design engineer to size the spacing and gauge of the element as well as the total depth of the member in the case of header and sill design.
   4. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   5. The contractor's fabricator shall provide a full set of engineering calculations as well as a complete set of shop drawings affixed with a New York State Professional Engineer's sign and seal. The design of the cold-formed steel elements shall be in conformance with the information shown on the contract documents and shall be in accordance with the 2020 Building Code of New York State.

C. Fabrication Drawings:

1. Prior to fabrication submit fabrication and erection drawings for review and approval by the architect/ engineer. Indicate component details, framing for openings, bearing anchorage, temporary bracing, welds or type and location of mechanical fasteners and accessories or items required of other work for complete installations. Included manufacturer's instructions for securing studs to tracks and for other framing connections.
2. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:
1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

D. Research Reports: For non-standard cold-formed steel framing, from ICC-ES.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 to conduct the testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

D. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

E. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ClarkDietrich Building Systems, LLC.
   2. MarinoWARE
   3. Architect/ Engineer approved equivalent.

2.02 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
   1. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
      a. Interior non-load-bearing Wall Framing: Horizontal deflection of 1/360 of the wall height under a horizontal load of 5 lbf/sq. ft.
      b. Exterior Soffit Support Framing: Out of plane deflection of L/120 under snow, wind and dead loads, or as otherwise specified by manufacturer.
      c. Exterior Supports for Standing seam metal roof: Out of plane deflection of L/180 under snow, wind and dead loads, or as otherwise specified by the manufacturer.
      d. Exterior supports for wall panels: Out of plane deflection of L/360 under wind loads, or as otherwise specified by the manufacturer.

2.03 COLD-FORMED STEEL FRAMING, GENERAL

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.

B. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: ST33H.
2. Coating: G90 or equivalent.

C. Steel Sheet for Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:
1. Grade: 50, Class 1 or 2.
2. Coating: G90.

D. All studs and/or joists and accessories shall be the type, size, gage, and spacing shown on the plans. Studs, runners (track) bracing, and bridging shall be manufactured per ASTM C955.

E. All galvanized studs, joists, and accessories shall be formed from steel that conforms to the requirements of ASTM A653/A653M, as set forth in Section 1.02 of the AISI specification for design of cold-formed steel structural members.

F. All galvanized studs joists and accessories shall have a minimum G60 coating.

G. Minimum steel gauges shall be 18 gauge for all structural elements subject to gravity and/or lateral wind forces.

H. Minimum steel gauge for interior elements subject to partition loadings shall be 20 gauge.

I. All section properties shall be calculated in accordance with the AISI specification for the design of cold-formed steel structural members (latest edition).

J. Facing materials may not be substituted for bridging. Horizontal bridging must be installed prior to loading the wall and/or floor/roof joists.

K. The physical and structural properties published by approved supplier will be accepted; otherwise these properties must be substantiated by calculations for loading stresses and deflections of the designed framing sealed by a professional engineer licensed in the State of New York.

L. Prior to fabrication submit fabrication and erection drawings for review and approval by the architect/ engineer. Indicate component details, framing for openings, bearing anchorage, temporary bracing, welds or type and location of mechanical fasteners and accessories or items required of other work for complete installations. Included manufacturer's instructions for securing studs to tracks and for other framing connections.

2.04 SOFFIT FRAMING

A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch, 18 gauge or as indicated on the construction documents..
2. Flange Width: 2 inches, minimum.

2.05 ROOF FRAMING

A. Roof Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0538 inch, 16 gauge or as indicated on the construction documents..
   2. Flange Width: 2 inches, minimum.

2.06 RIGID FURRING CHANNELS

A. Rigid Furring Channels: Hat-Shaped channels for furring out walls, ASTM C645.
   1. Minimum Base-Metal Thickness: 20 gauge (0.033 inch). or as indicated on the construction drawings.
   2. Depth: 7/8 inch, 1-1/2 inches as indicated on the drawings.

2.07 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   1. Supplementary framing.
   2. Bracing, bridging, and solid blocking.
   3. Web stiffeners.
   4. Anchor clips.
   5. End clips.
   6. Stud kickers and knee braces.
   7. Hole reinforcing plates.
   8. Backer plates.

2.08 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

B. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.

C. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated

according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E1190 conducted by a qualified testing agency.

D. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
   1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

E. Welding Electrodes: Comply with AWS standards.

F. Column Flange Grip Clips: Pre-manufactured Column/Beam connectors for rapid installation of board type materials to Steel Column and Beam Flanges. ASTM A1003/A1003M Structural Grade 33 (230) Type H, ST33H (ST230H): 33ksi (230MPa) minimum yield strength, 45ksi (310MPa) minimum tensile strength, 27mil minimum thickness (22 gauge, 0.0283" design thickness) with ASTM A653/A653M G60 (Z180) hot dipped galvanized coating. Manufacturer: The Steel Network, Inc. Unit connection box measures 1 inch deep, 2 inches wide and 2 1/2 inches long with a spring clip depth of 2.375 inches and a curved clip spring clearance of .2 inches.
   1. Install as indicated on the drawings. Maximum spacing 24 inches on center.

2.09 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780/A780M.

B. Shims: Load bearing, high-density multimonomer plastic, and non-leaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

C. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.10 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   1. Fabricate framing assemblies using jigs or templates.
   2. Cut framing members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
   1. Cut framing members by sawing or shearing; do not torch cut.
   2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work. Welds may be butt, fillet, spot or groove type. The appropriateness of which shall be determined by and within the design calculations. All welds shall be touched-up using zinc -rich paint to galvanized members and paint similar to that used by the manufacturer for painted members.
      b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

D. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

E. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

F. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

G. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

H. Wire tying in structural applications is not permitted.

3.03 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. All members shall be checked for proper alignment, bearing, completeness of attachments, proper placement and reinforcing.

D. Testing agency will report test results promptly and in writing to Contractor and Architect.

E. Remove and replace work where test results indicate that it does not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.04 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

3.05 TOLERANCES

A. Vertical alignment (plumbness) of studs shall be within 1/8 inch in 4 feet of the span.

B. Horizontal alignment (levelness) of walls shall be within 1/8 inch in 4 feet of their respective lengths.

C. Spacing of studs shall not be more than +1/8 inch from the designed spacing providing that the cumulative error does not exceed the requirements of the finishing materials.

+ + END OF SECTION + +

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SECTION 05500

METAL FABRICATIONS

PART 1 -- GENERAL

1.1 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal fabrications not specifically included in other Sections, complete and in accordance with the requirements of the Contract Documents.

B. Work shall include but may not be limited to lintels.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05050 - Metal Fastening

C. Section 05035 - Galvanizing

D. Certain specific items are included in other Sections of the Specifications. See the section for the specific item in question.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
   1. Building Code of New York State
   2. AISC - Specification for Structural Steel Buildings
   3. AISI - Specifications for the Design of Cold-Formed Steel Structural Members
   4. Aluminum Association Specifications for Aluminum Structures

1.4 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.
   1. Complete fabrication and erection drawings of all metalwork specified herein.
   2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

PART 2 -- PRODUCTS

2.1 METAL MATERIALS

A. Metal materials used in metal fabrications shall conform to Section 05010, Metal Materials, unless noted otherwise.

B. Back-to-back channels, called out in contract document as P1001 DF by UNISTRUT, INC., shall be factory treated with unistrut defender instead of galvanization, unless noted otherwise.

2.2 METAL FASTENING

A. All welds and fasteners used in metal fabrication shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.3 LINTELS

A. Provide lintels as shown on the Drawings and specified herein with 8 inches minimum bearing each side unless noted otherwise.

B. All lintels shall be steel in accordance with Section 05120, Structural Steel, and shall be galvanized in accordance with Section 05035, Galvanizing, unless noted otherwise.

2.4 STAINLESS STEEL WIRE MESH:

A. Type 316 stainless steel wire mesh for use in openings in concrete walls at the Ground Floor.
   1. Mesh Material: Type 316 stainless steel wire mesh.
      a. Wire mesh of 0.063-inch diameter wire (16-gauge) with 1/2-inch square openings, with minimum 76% free area. Basis-of-Design: Wire Mesh 31026348C5 by McNichols.
      b. Or approved equal.
   2. Frame Material: 14-gauge stainless steel frame sized to fit openings as indicated on the drawings.

PART 3 -- EXECUTION

3.1 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.

G. Fabricated items shall be shop painted when specified in Section 09900, Painting.

3.2 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions

C. Metal work shall be field painted when as specified in accordance with Section 09900, Painting.

+ + END OF SECTION + +

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SECTION 05505

ALUMINUM FABRICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Process Header Piping Exterior Support Framing.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including finishing materials.

B. Shop Drawings: Show fabrication and installation details for decorative metal.
   1. Fabrication drawings affixed with New York State P.E. sign and seal.
   2. A full set of connection calculations for beam to beam and beam to column connections affixed with a New York State P.E. sign and seal. The calculations shall adhere to the requirement of the 2020 New York State Building Code and Alumimum Design Manual.
   3. Include plans, elevations, component details, and attachments to other work.
   4. Indicate materials and profiles of each member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

1.04 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

C. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store decorative metal in a well-ventilated area, away from uncured concrete and

masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

B. Deliver and store cast-metal products in wooden crates surrounded by sufficient packing material to ensure that products will not be cracked or otherwise damaged.

1.06 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

1.07 COORDINATION

A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 ALUMINUM FABRICATORS

A. Fabricators: Subject to compliance with requirements, fabricators offering decorative metal work that may be incorporated into the Work include, but are not limited to, the following:
   1. DAMS Incorporated
   2. 3D Metal Fabricators
   3. National Metal Fabricators.

2.02 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. Provide materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.03 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.

B. Structural Framing: ASTM B308/B308M, Alloy 6061-T6.

C. Extruded Structural Pipe: ASTM B429/B429M, Alloy 6063-T6.

D. Plate and Sheet: ASTM B209/B209M, Alloy 6061-T6.

2.04 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:
   1. Aluminum Items: Type 316 stainless-steel fasteners.

B. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

C. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless otherwise indicated.
   1. Provide square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

E. Post-Installed Anchors: Torque-controlled expansion type.

1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 (A4) stainless-steel bolts, ASTM F593 (ASTM F 738M), and nuts, ASTM F594 (ASTM F 836M).

2.05 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.06 FABRICATION, GENERAL

A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

B. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.

C. Form aluminum to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

E. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

F. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.

G. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

H. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.

I. Comply with AWS for recommended practices in shop welding. Weld behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded joints of flux, and dress exposed and contact surfaces.
   1. Where welding cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 2 Welds: completely sanded joint, some undercutting and pinholes okay.

2.07 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.08 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.

B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
   1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude non-uniform oxidation and discoloration.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.03 CLEANING AND PROTECTION

A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

B. Protect finishes of aluminum from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.

C. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

+ + END OF SECTION + +

SECTION 05510

METAL STAIRS AND RAILINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

B. Section 06280 - Glass Fiber Reinforced Plastic Fabrications. For fiberglass treads and risers, where indicated on drawings.

1.02 SUMMARY

A. Section Includes:
   1. Pre-assembled steel stairs with concrete-filled treads and landings.
   2. Steel tube railings attached to metal stairs.
   3. Steel tube handrails attached to walls adjacent to metal stairs.
   4. Glass fiber reinforced stair treads for use in metal framed stairs.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
   1. Uniform Load: 100 lbf/sq. ft (4.79 kN/sq. m).
   2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in (2580 sq. mm).
   3. Uniform and concentrated loads need not be assumed to act concurrently.
   4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
   5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch (6.4 mm), whichever is less.

C. Structural Performance of Handrails and Railings: Handrails and railings shall withstand the structural loads required by ASCE 7 without exceeding the allowable design working stress of the materials for handrails, railings anchors and connections. Gravity loads and the following loads and stresses within the limits and under the conditions indicated:
   1. Handrails and Top Rails of Guards:
      a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.

b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:
   a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).

D. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7, Minimum Design Loads for Buildings and Other Structures": Section 9 "Earthquake Loads".
   1. Component Importance Factor is 1.15.

E. Stair Tread Design:
   1. Load/Deflection: Fibertred® stair treads shall meet manufacturer's published recommended loading with deflection not to exceed the following:
      a. Concentrated load of 500 pounds, placed at the centerline of a 36" tread span with a maximum deflection not to exceed 0.32".
      b. The concentrated load is applied at the centerline of the tread, over a width of 4" and a depth of 6", starting at the nosing edge to simulate the landing of a foot.
      c. The manufacturer shall certify that the stiffness of all panels manufactured are never more than 2.5% below the published load-deflection values.

1.04 ACTION SUBMITTALS

A. Product Data: For metal stairs and the following:
   1. Refilled metal-pan stair treads.
   2. Abrasive nosings.
   3. Paint products.
   4. Grout.
   5. FRP Fabrications.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Provide templates for anchors and bolts specified for installation under other sections.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Welding certificates. Certified welder employed on the work shall have AWS Certification within the previous 12 months.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs.

E. Special Inspection Requirements:
   1. Where materials, welding procedures and qualifications of welders are verified prior to the start of work, periodic inspections of the work in progress and a visual inspection of all welds are made prior to shipping of shop welding, continuous special inspections of welding will not be required.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Professional Engineer Qualifications: A Professional Engineer who is legally qualified to practice in the state in which the project is located and who is experienced in providing engineering services of the type indicated and required for this section of the work. Engineering services are defined as those performed for installations of Metal Stairs including handrails and railing systems, that are similar to those indicated for this project in material, design and extent.

C. Fabricator Qualifications: A firm experienced in producing Metal Stairs similar to those indicated for this project and with a record of successful in-service performance, as well as sufficient production capability to produce the required units.

D. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
   1. Preassembled Stairs: Commercial class.

E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

F. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum".
   3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.07 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.01 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.02 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Steel Tubing: ASTM A500/A500M (cold formed).

D. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M, either commercial steel, or structural steel, Grade 25 (Grade 170), unless another grade is required by design loads; exposed.

2.03 ABRASIVE NOSINGS

A. Cast-Metal Units: Cast aluminum, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. American Safety Tread Co., Inc.
      b. Balco Inc.
      c. Barry Pattern & Foundry Co., Inc.
      d. Safe-T-Metal Company, Inc.
      e. Wooster Products Inc.
   2. Configuration: Cross-hatched units, 3 inches (75 mm) wide without lip.

B. Extruded Units: Aluminum units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Safety Tread Co., Inc.
      b. Balco Inc.

c. Wooster Products Inc.

C. Nosings: Two-piece units, 4 inches (101.6 mm) wide, with subchannel for casting into concrete.
   1. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

D. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.

E. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

2.04 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).

D. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).

E. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).

F. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
   1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
   2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 2 (A4) stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

2.05 FIBER REINFORCED PLASTIC (FRP) MATERIALS

A. Pultruded FRP Materials:
   1. Materials used in the manufacture of the FRP products shall be raw materials in conformance with the specification and certified as meeting the manufacturer's approved list of raw materials.
   2. All structural shapes are to be manufactured by the pultrusion process with a glass content minimum of 45%, maximum of 55% by weight. The structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities,

properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.

3. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
4. The visual quality of the pultruded shapes shall conform to ASTM D4385.
5. FRP guardrail/handrail shall be manufactured using a pultruded process utilizing vinyl ester resin with flame retardant and ultraviolet (UV) inhibitor additives. Unless a phenolic resin system is utilized, a synthetic surface veil fabric shall encase the glass reinforcement. FRP shapes shall achieve a flame spread rating of 25 or less in accordance with ASTM test method E84, the flammability characteristics of UL 94 V0 and the self-extinguishing requirements of ASTM D635.
6. FRP products exposed to weather shall contain an ultraviolet inhibitor. Should additional ultraviolet protection be required, a one mil minimum UV coating may be applied. Products manufactured with a phenolic resin system shall be coated with a one mil minimum UV coating.
7. All exposed railing surfaces shall be smooth and true to form, consistent with ASTM D4385.

Fiberglass Pultruded Material Properties

Properties	Test	Units	Value	
Tensile Strength	ASTM D790	psi	30,000	
Tensile Modulus	ASTM D638	psi	2.5 x 10^6	
Flexural Strength	ASTM D790	psi	30,000	
Flexural Modulus	ASTM D790	psi	1.8 x 10^6	
Flexural Modulus (Full Section)		psi	2.8 x 10^6	
Short Beam Shear (Transverse)	ASTM D2344	psi	4,500	
Shear Modulus (Transverse)	N/A	psi	4.5 x 10^5	
Coefficient of Thermal Expansion	ASTM D696	in/in/deg F	8.0 x 10^-6	
Flame Spread	ASTM E84	N/A	25 or less	

2.06 FRP STAIR TREADS

A. FRP Stair treads shall be Fibertred® as manufactured by Fibergrate Composite Structures Incorporated or approved equal. Fibertred® stair treads shall be of a one-piece molded construction and shall have a 1 1/2 inch x 6 inch rectangular mesh pattern providing unidirectional strength in the tread span direction. Fibertred® shall be reinforced with continuous rovings in each direction. The top layer of reinforcement shall be no more than 1/8 inch below the top surface of the tread so as to provide maximum stiffness and prevent resin chipping of unreinforced surfaces. Percentage of glass (by weight) shall not exceed 35% so as to achieve maximum

corrosion resistance, and as required to maintain the structural requirements. After molding, no dry glass fibers shall be visible on any surface of bearing bars or cross bars. All bars shall be smooth and uniform with no evidence of fiber orientation irregularities, interlaminar voids, porosity, resin rich or resin starved areas.

B. Non slip surfacing: Fibertred® stair treads shall be manufactured with a concave, meniscus profile on the top of each bar providing maximum slip resistance. For additional safety, and to meet OSHA requirements, stair treads shall be manufactured with a 1 1/2 inch solid, molded nosing. Nosing shall be gritted with an angular quartz grit, integrally molded into the top surface of the nosing area only.

C. Fire rating: Fibertred® stair treads shall be fire retardant with a tested flame spread rating of 25 or less when tested in accordance with ASTM E84. Test data performed only on the resin shall not be accepted.

D. Resin system: The resin system used in the manufacture of Fibertred® stair treads shall be Vi-Corr®. Manufacturer may be required to submit corrosion data from tests performed on actual stair tread products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of stair tread product corrosion resistance and shall not be accepted.

E. Thickness: 1-1/2 inch thick with a tolerance of plus or minus 1/16 inch.

F. Mesh Configuration: 1-1/2 inch x 6 inch rectangular mesh pattern with double cross bars on 6 inch centers which allows optimum utilization and ease of fabrication.

G. Hardware: Type 316 stainless steel hold down clips shall be provided and spaced as recommended by the manufacturer. A minimum of four hold-down clips shall be required for each tread.

2.07 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Section 09900 - Painting

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, non-gaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

D. Concrete Materials and Properties: Comply with requirements in Division 03 for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 4000 psi (20 MPa) unless otherwise indicated.

E. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and non-glazing; unaffected by freezing, moisture, or cleaning materials.

F. Welded Wire Fabric: ASTM A 185/A 185M, 6 by 6 inches (152 by 152 mm), W1.4 by W1.4, unless otherwise indicated.

2.08 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
   1. Join components by welding unless otherwise indicated.
   2. Use connections that maintain structural value of joined pieces.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Weld exposed corners and seams continuously unless otherwise indicated.
   5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.09 STEEL-FRAMED STAIRS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alfab, Inc.

2. American Stair, Inc.
3. Sharon Companies Ltd. (The).

B. Stair Framing:
1. Fabricate stringers of steel plates or channels tubes or a combination of both as indicated.
2. Provide closures for exposed ends of channel or tube stringers.
3. Construct platforms of steel tube headers and miscellaneous framing members as indicated.
4. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.067 inch (1.7 mm).
1. Steel Sheet: Galvanized and primed cold-rolled steel sheet.
2. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
3. Shape metal pans to include nosing integral with riser.
4. At Contractor's option, provide stair assemblies with metal-pan subtreads filled with reinforced concrete during fabrication.
5. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.
a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.
6. When indicated, provide Hot-Dip galvanized completed fabrications with a factory primer ready for field painting.

2.10 STAIR RAILINGS

A. Steel Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads. Rails shall be Mesh infill or two-rail system as indicated on drawings.
1. Rails and Posts: 1-1/2-inch round top and bottom rails and 1-1/2-inch round posts.
2. Mesh Infill Panels – provide type 316 stainless steel screens constructed of .5" x .5" x .063” (12.7 mm x 12.7 mm x 1.60 mm) stainless steel wire mesh. Set into type 316 18 gauge stainless-steel 1-inch deep closed channel frames sized to fit within a ½-inch between top, bottom rails and posts separated with ½-inch diameter schedule 40, aluminum panel clips that overlap the frame and are secured to the top and bottom rails spaced no more than 24-inches apart. Locations shall be as indicated on the contract documents.

3. Two Rail System, exclusive of handrail, include intermediate Rails infill, 1-1/2-inch round intermediate rails spaced less than 21 inches clear or as shown on the drawings.
4. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with cam-type, self-closing hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

B. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
1. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.

C. Form changes in direction of railings as follows:
1. As detailed.
2. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.

D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

E. Close exposed ends of railing members with prefabricated end fittings.

F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.

G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
1. Connect posts to stair framing by direct welding unless otherwise indicated.
2. For non-galvanized railings, provide non-galvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

2.09 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   1. Interior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

G. Place and finish concrete fill for treads and platforms to comply with Division 03.
   1. Steel trowel concrete to a smooth finish, free of trowel marks and uniform in texture and appearance. allow concrete to cure for three days. Do not allow traffic on concrete.
   2. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.

3.02 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.

B. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
   1. Use nonmetallic, nonshrink grout unless otherwise indicated.
   2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.03 INSTALLING RAILINGS

A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
   1. Anchor posts to steel by welding directly to steel supporting members.
   2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.

B. Attach handrails to wall with wall brackets. Use type of bracket with predrilled hole for exposed bolt anchorage. Provide bracket with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as follows:
   1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
   2. For hollow masonry anchorage, use toggle bolts.
   3. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.04 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09900 - Painting

+ + END OF SECTION + +

SECTION 05522

ALUMINUM HANDRAILS AND RAILINGS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as specified, and required to furnish and install aluminum handrail and railing systems. The Work also includes:
      a. Provide an aluminum two-rail and three-rail system with toeboards at all required locations.
      b. Providing openings in, and attachments to, aluminum handrail and railing systems to accommodate the Work under this and other Specification Sections. Provide all items for aluminum handrails and railings, including anchorages, fasteners, studs, and other items required for which provision for is not specifically included under other Sections.
   2. Aluminum handrails and railings Work shall include components and features specified, and all components and features available from specified manufacturers required for providing complete aluminum handrail and railing system in accordance with the Contract Documents.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before aluminum handrails and railings Work.
   2. Aluminum handrail and railing locations shall conform with Laws and Regulations.

C. Related Sections:
   1. Section 05050, Metal Fastening.
   2. Section 05210, Structural Steel.
   3. Section 09900, Painting.

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. Aluminum Association (AA), Aluminum Design Manual.
   2. ASTM B26/B26M, Specification for Aluminum-Alloy Sand Castings.
   3. ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
   4. ASTM B136, Standard Method for Measurement of Stain Resistance of Anodic Coatings on Aluminum.

5. ASTM B137, Standard Test Method for Measurement of Coating Mass per Unit Area on Anodically Coated Aluminum.
6. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
7. ASTM B241/B241M, Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
8. ASTM B244, Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments.
9. ASTM B247, Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and rolled Ring Forgings.
10. ASTM B429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
11. ASTM E329. Standard Specification for Agencies Engaged in Construction Inspection, Testing or Special Inspection.
12. ASTM E935, Standard Test Methods for Permanent Metal Railing Systems and Rails for Buildings.
13. ASTM E985, Standard Specification for Permanent Metal Railing System and Rails for Buildings.
14. NAAMM/Architectural Metal Products Division (AMP), Pipe Railing Manual.
15. NAAMM/AMP AMP 501 Finishes for Aluminum.

1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall be able to document at least five years successful experience in fabricating aluminum handrail and railing systems of scope and type similar to that required.
      b. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency in compliance with ASTM E329. Such inspections and tests shall not relieve the Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
   2. Professional Engineer:
      a. Contractor or handrail and railing manufacturer shall retain a registered professional engineer licensed to practice in the State of New York.
      b. Responsibilities include:
         1) Reviewing aluminum handrail and railing system performance and design criteria stated in the Contract Documents.
         2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
         3) Preparing or supervising preparation of design calculations verifying compliance of aluminum handrail and railing system with requirements of the Contract Documents.

4) Signing and sealing all calculations.
5) Certifying that:
(a) Design of aluminum handrail and railing system was performed in accordance with performance and design criteria stated in the Contract Documents, and
(b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.

3. Installer Qualifications:
a. Retain a single installer skilled, trained and with record of successful experience in installing aluminum handrail and railing systems.
b. Installer shall have record of successfully installing aluminum handrail and railing systems in accordance with recommendations and requirements of manufacturer, or shall provide evidence of being acceptable to the manufacturer.
c. Installer shall employ only tradesmen with specific skill and successful experience in the type of Work required.
d. When requested by Engineer, submit name and qualifications of installer with the following information for at least three successful, completed projects:
1) Names and telephone numbers of owner and architect or engineer responsible for each project.
2) Approximate contract cost of the aluminum handrail and railing systems for which installer was responsible.
3) Amount (linear feet) of aluminum handrail and railing installed.

4. Testing Agency Qualifications: To qualify for approval, an independent testing agency shall demonstrate to Engineer's satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the work in accordance with ASTM E329.

B. Component Supply and Compatibility:
1. Obtain all products included in this Section regardless of component manufacturer, from a single aluminum handrail and railing system manufacturer.
2. Aluminum handrail and railing system manufacturer shall review and approve or prepare all Shop Drawings and other submittals (except for delegated design submittals, when professional engineer is retained by other than handrail and railing manufacturer) for all components furnished under this Section.
3. Components shall be specifically constructed for specified service conditions and shall be integrated into overall assembly by aluminum handrails and railings manufacturer.

C. Regulatory Requirements: Conform to Laws and Regulations including:
1. OSHA Part 1910.23, Guarding Floor and Wall Openings and Holes.
2. Building Codes of New York State, 2020.

D. Certifications:

1. Furnish certification, signed by authorized officer of manufacturer and notarized, stating that handrail and railing systems conform to the design prepared by the professional engineer.
2. Furnish certification, signed by authorized officer of Contractor and notarized, stating that all components and fittings are furnished by the same manufacturer.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings for fabrication and installation of aluminum handrail and railing systems with sizes of members, pipe wall thickness, information on components, and anchorage devices. Show all anchorages. Provide details drawn at scale of 1.5-inch equal to one foot.
      b. Indicate required location of posts.
      c. Indicate locations and details of all expansion joints, if any.
      d. Indicate locations and details of gaps across seismic joints, if any.
      e. Profile drawings of aluminum handrail and railing system components.
      f. Custom detail drawings. Details of forming, jointing, sections, connections, internal supports, trim and accessories. Provide details drawn at scale of 1.5-inch equal to one foot.
   2. Product Data:
      a. Manufacturer's specifications, standard detail drawings, and installation instructions for aluminum handrail and railing systems.
      b. Manufacturer's catalogs showing complete selection of standard and custom components and miscellaneous accessories for selection by Engineer.
   3. Delegated Design Submittals:
      a. Design Data:
         1) Design computations or complete structural analysis of handrail and railing systems, signed and sealed by professional engineer licensed to practice in the State of New York. Professional engineer's seal shall be clearly legible, including state of registration, registration number, and name on seal.
         2) Certification by professional engineer that professional engineer has performed design of aluminum handrail and railing systems in accordance with performance and design criteria stated in the Contract Documents, and that design conforms to all local, state, and federal Laws and Regulations, and to prevailing standards of practice.
   4. Samples:
      a. Full-size Sample, 2.0 feet long, of assembled railing system at post and rail intersections. Sample shall have all associated components including typical connections, mounted toeboard and sleeve, and handrail at wall return, complete with mounting brackets, all with specified controlled uniform metal finish.

b. Color Samples: Maximum range of clear anodized aluminum that shall appear in finished Work. Prepare range Samples, to show highest level of color control feasible for actual handrail and railing systems, as determined by licensor of finishing process specified, on actual extrusions and castings of the Work.
c. Samples will be reviewed for finish, color, joint tolerances, workmanship, and general component assembly only. Compliance with other requirements is the responsibility of the Contractor.

5. Test Procedure: Submit detailed description of proposed shop testing procedures. Do not perform shop testing until Engineer approves shop test procedure:

B. Informational Submittals: Submit the following:
1. Certificates:
a. Certification on source of supply, as specified in this Section.
b. Manufacturer certification specified in this Section.
2. Source Quality Control Submittals:
a. Manufacturer's load testing report in accordance with ASTM E935 for completed aluminum handrail and railing systems, demonstrating compliance with applicable requirements of building codes, safety codes, and other Laws and Regulations.
3. Qualifications Statements: Submit qualifications for the following:
a. Manufacturer, when requested by Engineer.
b. Professional engineer.
c. Installer, when requested by Engineer. Qualifications statement shall include record of experience with references specified.

C. Closeout Submittals: Submit the following:
1. Maintenance Manuals: Furnish detailed maintenance manuals that include the following:
a. Product name and number.
b. Detailed procedures for routine maintenance and cleaning, including cleaning materials, application methods and precautions in use of products that may be detrimental to finish when improperly applied.
c. Handrail and railings systems manufacturer's current catalog including individual parts.
2. Guarantee: Provide in maintenance manual the guarantee specified.

1.05 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver aluminum pipe railing and handrail and all accessories dry and undamaged, with manufacturer's protective coating intact, bearing original intact factory labels.
2. Aluminum pipe railing systems which are damaged during delivery or while being unloaded shall not be stored on Site. Remove such units from Site and replace panels with new, undamaged material.

3. Do not subject aluminum welded pipe railing and accessory materials to bending or stress. Do not carry or transport panels in the horizontal (flat) position. Hold panels upright on edge when handling.
4. Maintain protective covering on railings and handrails. System components which are damaged during installation shall be removed from Site and replaced with new, undamaged material.

B. Storage of Materials:
1. Store aluminum pipe railing and accessory materials in a dry location and in a manner that will protect strippable coating from exposure to sun and condensation; with good air circulation around each piece and with protection from windblown rain.
2. Store aluminum pipe railing and accessory materials under tarpaulin covers and in an area protected from dirt, damage, weather and from the construction activities of all Contractors. Do not store outside or allow items to become wet or soiled in any way while on Site.
3. Do not store in contact with concrete, earth or other materials that might cause corrosion, staining, scratching or damage to finish. Do not install system components which become dented, scratched or damaged in any way. Remove such components from Site and replace with new, undamaged material.

C. Handling of Materials:
1. Do not subject aluminum pipe railing and accessory materials to bending or stress.
2. Do not damage edges or handle material in a manner that will cause scratches, warps or dents.
3. Keep on-Site handling to a minimum.
4. Maintain protective covering on railings and handrails. All surface protective coverings such as non-adhesive papers, adhesive papers and strippable plastic films shall be removed after receipt at the Site as soon as there is no longer a need for the protection.

1.06 GUARANTEE

A. Guarantee: Manufacturer shall provide written guarantee of availability of replacement parts and components for period of at least five years after completion of the Project.

PART 2 – PRODUCTS

2.01 SYSTEM PERFORMANCE

A. System Description: Aluminum handrail and railing system shall consist of equally spaced horizontal rails with totally concealed mechanical fasteners, internally threaded tubular rivets and components fastened to posts spaced no more than 5.0 feet on centers and system of handrails supported from adjacent construction by mounting brackets spaced at no more than 5.0 feet on centers.

B. Design Criteria and Performance Criteria:

1. Maintain the visual design concept shown, and the technical requirements specified, including modules, profiles, alignment of components and requirements for finish.
2. Contractor shall provide aluminum pipe handrail and railing system that conforms to the State of New York Building Code Chapter 16 and ASTM E985, without exceptions, including the requirement that specific types of occupancies and sizes of contributing protected areas shall incorporate greater design load resistance into aluminum pipe railing system, in compliance with ASTM E985, than that specified herein.
    a. Completed handrail and railing shall withstand a uniform lateral force of 50 pounds per linear foot and a vertical uniform downward force of 50 pounds per linear foot, both applied simultaneously at the top of the handrail and railing, performance tested in accordance with Test Method A and B of ASTM E935.
    b. Intermediate and bottom rails shall withstand simultaneously applied lateral uniform forces of 40 pounds per linear foot and a vertical load of 50 pounds per linear foot, however, lateral and vertical loads on intermediate and bottom railings need not be considered in the detailing and fabrication of posts and anchorages.
    c. For railings having solid panels or picket balusters, the panels or picket balusters shall be detailed and fabricated to withstand a uniform lateral load of 50 pounds distributed over any round or square area of one square foot located anywhere within the infill area or a 50 pound per foot penetration cone, performance tested in accordance with Test Method C and D of ASTM E935.
    d. Concentrated 200 pound load and uniform force conditions shall not be applied simultaneously.
    e. Other pertinent requirements ceded to ANSI A1264.1 by governing authorities having jurisdiction at the Site.
    f. Bending stresses shall not exceed 60 percent of the yield stress of the material. Applied loads shall not produce permanent residual deformation in the completed work when loads are removed. Load-deformation data shall be determined in accordance with ASTM E935.
    g. Maximum allowable deflections shall be in accordance with ASTM E985.
    h. Where computations make it possible to provide the needed information, testing, in compliance with ASTM E935, shall be performed for verification that aluminum pipe railing system and auxiliary system components comply with specified performance requirements and the requirements of governing authorities having jurisdiction.
    i. Design shall also include the attachment of light fixtures, light fixture brackets and supplemental metal trim.
3. Thermal Control: Provide adequate expansion within the fabricated system that allows for a thermal expansion and contraction caused by a material temperature range of 140 degrees F to -20 degrees F without warp or bow of system components. Distance between expansion joints shall be based on providing a 1/4

inch wide joint at 70 degrees F which accommodates a movement of 150 percent of the calculated amount of movement for the specified temperature range.

4. Provide expansion joints in handrail and railing system work where systems cross expansion joints in structure.
5. Configuration of all aluminum pipe handrail and railing systems shall be as shown on the Contract Drawing. All details shown on the Contract Drawings are typical; similar details apply to similar conditions, unless specifically noted otherwise on the Contract Drawings.
6. Manufacturer is responsible for structural analysis and detailing of aluminum pipe handrail and railing system. Provide complete structural performance calculations and Working Drawings for all aluminum pipe handrail and railing members, anchors and all other support system components prepared, signed and stamped with the seal of a registered professional engineer licensed to practice in the State of New York and recognized as an expert in the specialty involved.

2.02 MATERIALS

A. Extruded Aluminum Architectural and Ornamental Shapes: ASTM B221, Alloy 6063-T52.

B. Aluminum Forgings: ASTM B247, Alloy 6061-T6.

C. Extruded or Drawn Aluminum Pipe and Tube:
   1. ASTM B429 or ASTM B241, Alloy 6063-T5, 6063-T52, or 6063-T832 as required by loadings, deflections, and post spacing specified.
   2. Provide Schedule 40 pipe, minimum, unless conditions of detail and fabrication require extra-heavy pipe to comply with Specifications. Rails and posts shall have minimum outside diameter of 1.90 inches.

D. Reinforcing Bars: Solid, circular profile, 24 inches long, 6061-T6 aluminum reinforcing bars with same outside diameter as inside diameter of post.

E. Anchors and Fastenings: As specified in Section 05050, Metal Fastening.

F. Handrails and Railings: Handrail systems shall consist of all railings, posts, toeboards, baseplates, anchors, and accessories required for a complete and rigid installation.
   1. Metal railings shall be fabricated from 1-1/2 inch Schedule 40 pipe. Metal railing support posts shall be fabricated from 1-1/2 inch Schedule 80 pipe.
   2. The centerline of the top guard rail shall be 42 inches above the walking surface for level rail. For stair rail, the centerline of the top guard rail shall be 42 inches above the leading edge of the tread nosing. Stair handrail shall be 34 inches above the leading edge of the tread nosing.
   3. Posts:
      a. Maximum horizontal spacing between posts for level rail shall be five feet.
      b. Maximum horizontal spacing between posts for stair rail shall be four feet.
   4. Post Plates:

a. Custom aluminum profile fabricated from 1/2-inch thick aluminum plate.
b. Spacing, configurations, and profile, as indicated on drawings.
c. Fasteners as indicated on drawings or per delegated design submittals.

5. All rail joints shall be finished flush and shall occur only at supports. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations. The top surface of the top railing shall be smooth and shall not be interrupted by projecting fittings.
6. Toeboards:
   a. Toeboard, cover extrusions and attachments shall project 4-inches above the walking surface and shall not infringe on the minimum required walkway width.
   b. Aluminum toeboards shall be extruded from aluminum alloy 6063-T6 unless otherwise noted.
   c. Toeboards shall have a minimum thickness of 1/8" at any point. Geometry of toeboard shall closely resemble geometry shown on Drawings.
7. Expansion joint splices shall be provided at 30 foot maximum spacing and at all expansion joints in the structure supporting the handrail.
8. The handrail system shall be designed to resist the design loads specified by both OSHA and the New York State Building Code.
9. Provide handrail extensions at top and bottom of stairs and ramps in accordance with the New York State Building Code
10. Handrail shall be Four Rail handrail systems or as shown on the Drawings. If no type is indicated on Drawings, handrail shall be four rail system.
    a. Four-rail system with custom vertical flat plate posts spanning between all rails.
       1) The centerline of the lower intermediate rail shall be 5-1/2 inches above the walking surface.
       2) The centerline of the two intermediate rails shall be equally spaced between the top and bottom rail.
       3) The top of the upper rail shall be 3'-6" above the walking surface.

2.03 FABRICATION

A. General: Unless otherwise shown or specified, provide typical non-welded construction details and fabrication techniques recommended in NAAMM/AMP Pipe Railing Manual and NAAMM/AMP AMP 501.

B. Fabricate handrail and railing systems true to line and level, with accurate angles surfaces and straight edges. Fabricate corners without using fittings. Provide bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces, or use prefabricated bends. Provide not less than four-inch outside radius.

C. Provide chains across openings in railings where shown. Attach one end of each chain to an eyebolt in post and other end attached by means of swivel eye snap hook to similar eyebolt in opposite post.

D. Remove burrs from exposed edges.

E. Close aluminum pipe ends by using prefabricated fittings.

F. Weep Holes:
   1. Fabricate joints that will be exposed to weather to exclude water.
   2. Provide 15/64-inch diameter weep holes at lowest possible point on each post in handrail and railing systems.
   3. Provide pressure relief holes at closed ends of handrail and railing systems.

G. Toeboards:
   1. Provide manufacturer's standard toeboard, which accommodates movement caused by thermal change specified without warping or bowing toeboards.
   2. Provide manufacturer's standard toeboard, which accommodates storage for removable socket covers.
   3. Coordinate and cope toeboard as required to accommodate cover flanges at posts.
   4. Toeboards shall follow curvature of railing. Where railing is shown to have curved contours at corners, or other locations, toeboard shall likewise be curved to follow line of railing system.

H. Reinforcing Bars: Provide reinforcing bar friction-fitted at each post in railing system. Extend reinforcing bars of tubes six inches into cast-in-place sleeves or other types of supporting brackets.

I. Mechanically Fitted Component Pipe Handrail and Railing System:
   1. Use non-welded pipe handrail and railing system with posts, top and intermediate rail(s), and flush joints.
   2. Provide top and one intermediate horizontal rail, equally spaced.
   3. Do not use blind rivets, pop rivets, or other exposed fastening devices in the Work. Fasteners used for side-mounting fascia flanges where shown or specified may be exposed in the Work. Provide internal threaded aluminum rivets, stainless steel through-bolts with lock nuts, stainless steel sheet metal screws with lock washers, and epoxy adhesive for fastening components of the Work.

2.04 FINISHES

A. General:
   1. Prepare surfaces for finishing in accordance with recommendation of aluminum producer and the finisher or processor.
   2. Adjust and control direction of mechanical finishes specified to achieve best overall visual effect in the Work.
   3. Color and Texture Tolerance: Provide uniform color and continuous mechanical texture for aluminum components. Architect reserves the right to reject aluminum

materials because of color or texture variations that are visually objectionable, but only where variation exceed range of variations established by manufacturer prior to fabrication, by means of range of Samples approved by Architect.

4. Powder coat all exposed aluminum components of the work.
5. Finish for all aluminum work of this specification: Provide fluorocarbon polymer powder coating for extruded or factory-fabricated material. Provide a minimum dry film thickness of 1.5 mil. coating system finish complying AAAMA specification 2605-5 Voluntary Specification for High Performance Organic Coatings on Architectural exposed extrusion and railings.
6. Exterior powder coating color to be selected from manufactures custom and premium palate.

2.05 SOURCE QUALITY CONTROL

A. Allowable Tolerances:
   1. Limit variation of cast-in-place inserts, sleeves and field-drilled anchor and fastener holes to the following:
      a. Spacing: Plus-or-minus 3/8-inch.
      b. Alignment: Plus-or-minus 1/4-inch.
      c. Plumbness: Plus-or-minus 1/8-inch.
   2. Minimum Handrails and Railings Systems Plumb Criteria:
      a. Limit variation of completed handrail and railing system alignment to 1/4-inch in 12.0 feet with posts set plumb to within 1/16-inch in 3.0 feet.
      b. Align rails so variations from level for horizontal members and from parallel with rake of stairs and ramps for sloping members do not exceed 1/4-inch in 12.0 feet.
   3. Provide “pencil-line” thin butt joints.

B. Factory Testing:
   1. Perform load test on completed handrail and railing systems. Extent of handrail and railing systems to be factory-tested shall be as shown and specified.
   2. Load test completed handrail and railing systems in accordance with requirements of ASTM E935. Provide written report to Engineer identifying and documenting testing methods used, magnitude and location of loads superimposed, and results of such tests on actual completed handrail and railing systems, including all anchors and fasteners to be used in the Work. Testing setup shall simulate actual conditions of installation to be used in the Work.
   3. Do not ship products from factory until Engineer accepts load testing report.

PART 3 – EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with all adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. Concrete anchors and bolts for attachment of handrail baseplates to supporting members shall conform to Section 05050, Metal Fastening.

G. All fabricated items shall be shop painted in accordance with Section 09900, Painting.

3.02 INSPECTION

A. Examine conditions under which Work is to be performed and notify Engineer, in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

B. Verify to Engineer gauge of aluminum pipe railing posts and rails brought to the Site by actual measurement of on-Site material in presence of Engineer.

C. Protection: Protect cast-in-place sleeves and field-drilled holes from debris and water intrusion by use of temporary covers or removable foam inserts that completely fill the cast-in-place sleeve.

D. Coordinate installation of anchorages for handrails and railings. Furnish setting drawings, templates, and installation instructions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in cast-in-place concrete or masonry. Deliver to Site in time for installation.

E. Verify dimensions by taking measurements at the Site without causing delay in the work. Where measurements cannot be taken at the Site without delaying the work, establish dimensions and proceed with fabrication of handrails and railings without Site measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

3.03 INSTALLATION

A. General:
   1. Do not erect components that have become scarred, dented, chipped, discolored, otherwise damaged or defaced. Remove from Site railing and handrail system components that have holes, cuts, gouges, deep scratches, or dents of any kind.

Repairs to correct such Work will not be accepted. Remove and replace with new material.

2. Comply with installation and anchorage recommendations of NAAMM/AMP Pipe Railing Manual and NAAMM/AMP AMP 501 in addition to requirements specified and approved or accepted (as applicable) submittals.

B. Fastening to In-Place Construction:
   1. Remove protective plastic immediately before installing.
   2. Adjust handrails and railings prior to securing in place, to ensure proper matching at butting joints and correct alignment throughout their length. Plumb posts in each direction. Secure posts and rail ends to building or structure as shown on drawings.

C. Assembly and installation of handrails and railings shall be performed in strict accordance with manufacturer's recommendations.

D. All handrails and railings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

E. Protection from Dissimilar Materials:
   1. Coat aluminum surfaces in contact with dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09900, Painting.
   2. Do not extend coating beyond contact surfaces. Remove coating where exposed-to-view in the finished Work.

3.04 CLEANING AND REPAIRING

A. Cleaning: Installer shall clean exposed surfaces of handrail and railing systems after completing installation. Comply with recommendations of both handrail and railing system manufacturer and finish manufacturer. Do not use abrasives or unacceptable solvent cleaners. Test cleaning techniques on an unused section of railing before employing cleaning technique.
   1. Remove stains, dirt, grease, and other substances by washing handrails and railings systems thoroughly using clean water and soap; rinse with clean water.
   2. Do not use acid solution, steel wool, or other harsh abrasives.
   3. If stain remains after washing, remove defective sections and replace with new material meeting requirements of this Section.

B. Handrails and railings shall be free from dents, burrs, scratches, holes, and other blemishes. Replace damaged or otherwise defective Work with new material that conforms with this Section at no additional cost to Owner.

C. At Substantial Completion, replace adjacent work marred by the Work of this Section.

+ + END OF SECTION + +

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SECTION 06100

ROUGH CARPENTRY

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, material, tools, equipment, and incidentals as shown, specified, and required to furnish and install all rough carpentry Work.
   2. The Work also includes:
      a. Providing openings in rough carpentry to accommodate the Work under this and other Sections and building into rough carpentry items such as sleeves, anchorages, inserts and other items to be embedded in or penetrating rough carpentry for which placement is not specifically provided under other Sections.
   3. Types of materials required include:
      a. Miscellaneous blocking, furring strips, and other miscellaneous wood framing.
      b. Lumber for temporary protection.
      c. Lumber for temporary support.
      d. Pressure treatment of lumber specified in this Section.
      e. Miscellaneous accessories.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before rough carpentry Work.

C. Related Sections:
   1. Section 05051, Anchor Systems.

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. ALSC PS 20, American Softwood Lumber Standard.
   2. ASME B18.2.1 Square and Hex Bolts and Screws, Inch Series.
   3. ASME B18.6.1 Wood Screws, Inch Series.
   4. ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   5. ASTM D2898, Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
   6. ASTM D5516, Test Method for Evaluating the Flexural Properties of Fire-Retardant Treated Softwood Plywood Exposed to Elevated Temperatures.

7. ASTM D5664, Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber.
8. ASTM D6305, Practice for Calculating Bending Strength Design Adjustment Factors for Fire-Retardant-Treated Plywood Roof Sheathing.
9. ASTM D6841, Practice for Calculating Design Value Treatment Adjustment Factors for Fire-Retardant-Treated Lumber.
10. ASTM F1667, Specification for Driven Fasteners: Nails, Spikes, and Staples.
11. AWPA M4, Care of Preservative Treated Wood Products.
12. AWPA P5, Waterborne Preservatives.
13. AWPA P17, Fire Retardant Formulations.
14. AWPA T1, Use Category System: Processing and Treatment Standard.
15. AWPA U1, Use Category System: User Specification for Treated Wood.
16. APA E445S, Performance Standards and Policies for Structural-Use Panels (APA PRP-108).
17. NIST PS-1, Construction and Industrial Plywood.
18. National Lumber Grade Authority (NLGA), Standard Grading Rules for Canadian Lumber.
19. Northeastern Lumber Manufacturers Association (NELMA), Standard Grading Rules for Northeastern Lumber.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of authorities having jurisdiction and the building codes referred on the drawings, References for size, spacing and attachment of wood members, unless more stringent requirements are shown or specified in the Contract Documents.

B. Certifications:
   1. Pressure Treatment: For each type of pressure treatment specified, submit certification by wood treating plant stating chemicals and process used, and certifying conformance with applicable standards referenced in the Contract Documents.
      a. For water borne preservatives, include statement that moisture content of treated materials was reduced to maximum of 19 percent prior to shipment to the Site.
   2. Certificates of Grade: Where appearance of wood is important and grade marks will deface the Work, in lieu of grade markings on wood, submit certificates attesting that materials comply with grade requirements specified.

1.04 SUBMITTALS

A. Action Submittals; Submit the following:
   1. Shop Drawings:
      a. List of species and grade of lumber proposed for each use.

b. Fastener schedule with location, size, material and type of each fastener to be used in the Work.

2. Samples:
   a. Provide Sample of each fastener tagged for use in the Work.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Lumber treater's certification of compliance, in accordance with Paragraph 1.3.B.1 of this Section.
      b. Certificates of grade in accordance with Paragraph 1.3.B.2 of this Section.
   2. Tests and Evaluation Reports:
      a. For fire retardant treated structural panels, test data and design adjustment values in accordance with ASTM D5516 and ASTM D6305.
      b. For fire retardant treated lumber, test data and design adjustment in accordance with ASTM D5664 and ASTM D6841.
   3. Manufacturer's Instructions:
      a. Chemical treatment manufacturer's instructions for proper use of each type of treated material.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete or masonry in ample time to prevent delaying the Work.
   2. Handle treated materials in accordance with AWPA M4.

B. Storage and Protection:
   1. Keep materials dry during delivery and storage.
   2. Keep materials off ground using pallets, platforms, or other appropriate supports. Protect materials from corrosion and deterioration. Stack lumber, and provide air circulation within stacks.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Lumber, General:
   1. Factory-mark each piece of lumber with type, grade, mill and grading agency. Surfaces that will be exposed to view shall not have grade marks or other types of identifying marks.
   2. Nominal sizes are shown or indicated, unless otherwise shown or indicated in the Contract Documents. Provide actual sizes as required by ALSC PS 20 for moisture content specified for each use.
      a. Provide dressed lumber, surfaced four sides (S4S), unless otherwise shown or specified.

b. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing.

3. Provide the following grade and species:
   a. Construction Grade, for material up to and including four-inch wide.
   b. No. 2 or better for material greater than four-inch wide up to and including 12-inch wide.
   c. Hem-Fir (North), NLGA, Southern Pine, SPIB or Douglas Fir, WWPA.
4. Lumber for Protection and Temporary Support: Size and grades to conform to Laws and Regulations, including OSHA.

B. Fasteners and Anchorages:
1. Fasteners exposed to the weather as well as fasteners embedded in, or in contact with, preservative treated wood shall be hot-dip galvanized.
2. Fasteners for fire retardant-treated lumber exposed to the weather shall be copper alloy.
3. Common wire nails shall conform to ASTM F1667.
4. Wood screws shall conform to ASME B18.6.1.
5. Lag screws and lag bolts shall conform to ASME B18.2.1.
6. Anchorage devices shall conform to Section 05051, Anchor Bolts, Toggle Bolts, and Concrete Inserts.

2.02 PLYWOOD

A. Qualities: Veneer-face composite or plywood panels, with 15% maximum moisture content, except 18% allowed after re-drying from pressure preservative treatment.

B. Plywood Equipment Mounting Panels; Telephone, IT and Electrical Equipment Backing Panels
1. 3/4" minimum nominal thickness using glues without urea formaldehyde.
2. Plies: Minimum 5.
3. Grade: APA DOC PS 1, C-D PLUGGED, Exposure 1.
4. Fire retardant treated.

2.03 WOOD TREATMENT

A. Preservative Treatment: Where lumber is specified in this Section as treated, comply with AWPA P5, "Alkaline Copper Quat Mixture". Mark each treated item to comply with AWPA quality mark requirements.
1. Pressure-treat above ground items with water-borne preservatives in accordance with AWPA U1 and AWPA T1. After treatment, kiln-dry to maximum moisture content of 19 percent. Treat materials indicated on the Drawings and the following:
   a. Wood nailers, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   b. Wood, plates, blocking, furring, stripping, and similar concealed members and wood in contact with masonry, concrete, or steel.

c. Soffit and rain drainage framing.

2. Complete the fabrication of treated items prior to treatment, wherever possible. If wood is cut after treatment, coat cut surfaces with heavy brush coat of same chemical used for treatment. Inspect each piece of wood after drying and discard damaged or defective pieces.

B. Fire Retardant Treatment: Where lumber is shown as fire retardant-treated, comply with the following:
   1. Fire retardants shall conform to AWPA P17. Fire retardant treatment of wood products shall conform to the requirements of AWPA U1 and AWPA T1. Treat materials indicated on the Drawings.
   2. Treated materials to be exposed to rain wetting shall be subjected to an accelerated weathering technique in accordance with ASTM D2898 prior to being tested.
   3. Treated materials that will be exposed to heat or humidity, shall receive exterior retardant treatment.
   4. Fire retardant treated wood shall be free of sulfates, halogens, ammonium phosphate, and formaldehyde.

PART 3 – EXECUTION

3.01 INSPECTION

A. Examine substrates and supporting structure and conditions under which rough carpentry Work will be installed and notify Engineer in writing of conditions detrimental to proper completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Coordination: Fit rough carpentry Work to other Work and work under other contracts, as applicable, and scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other construction.

B. General:
   1. Discard units of material with defects that might impair quality of the Work, and units too small to fabricate the Work with minimum joints or optimum joint arrangement.
   2. Set rough carpentry Work accurately to required levels and lines, with members plumb and true, accurately cut and fitted.
   3. Securely attach rough carpentry Work to substrates by anchoring and fastening as shown and indicated in the Contract Documents. Countersink nail heads on exposed rough carpentry Work and fill holes. Make tight connections between members.
   4. Install fasteners without splitting of wood, pre-drill as required and for masonry anchors fastened to wood stud wall framing.

C. Wood Grounds, Nailers, and Blocking:
   1. Provide where shown or indicated, and where required for attachment of other construction. Form to shapes as shown or indicated and cut as required for true line and level of Work to be attached. Coordinate location with other work involved.
   2. Attach substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise shown or indicated.
   3. Provide permanent grounds of dressed, preservative-treated, key-beveled lumber not less than 1.5-inch wide and of thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.

+ + END OF SECTION + +

SECTION 06120

CEMENTITIOUS - REINFORCED STRUCTURAL PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. Description of Work: Work of this Section includes, but is not limited to, the following:
   1. Cementitious-reinforced structural panels
   2. Fasteners.

1.02 SYSTEM DESCRIPTION

A. Structural Panel floor/roof system consists of steel joists, trusses or framing members and Structural Panel Concrete Subfloor installed with mechanical fasteners. Structural Panel Concrete Subfloor is a high-strength reinforced concrete panel for use in noncombustible construction, as required by the applicable building codes.

1.03 REFERENCES

A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2016, with Supplement (2020).

B. AISI S210 – North American Specification for Cold-Formed Steel Framing – Floor and Roof System Design

C. AISI S214 – North American Specification for Cold-Formed Steel Framing – Truss Design

D. AISI S230 – Standard for Cold-Formed Steel Framing – Prescriptive Method for One and Two Family Dwellings

E. ASTM A588/A588M - Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance; 2019.

F. ASTM D1037 - Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials; 2012 (Reapproved 2020).

G. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.

H. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2020.

I. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using

a Vertical Tube Furnace at 750°C; 2019a.

J. ASTM E492 - Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine; 2009, with Editorial Revision (2016).

K. ASTM E661 - Standard Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads; 2022.

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

M. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).

N. ASTM E989 - Standard Classification for Determination of Single-Number Metrics for Impact Noise; 2021.

O. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

P. ICC-ES AC318 – Acceptance Criteria for Structural Cementitious Floor and Roof Sheathing Panels

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include material descriptions, dimensions of individual components and profiles, and finishes for cementitious-reinforced panels.

B. Shop Drawings:
   1. Include plans, elevations, sections, dimensions, and attachment details.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Manufacturer Product Certificates: Indicate compliance with requirements of specified products in "Performance Requirements" Article or as indicated on Drawings.

1.06 SYSTEM REQUIREMENTS

A. Performance Requirements: Fabricate and install systems as indicated:
   1. Fasteners:
      a. Follow the selected fastener layout for Screw Patterns, for the design Diaphragm Loads as described in the current Progressive Engineering, Inc.'s Evaluation Report PER-13067.
   2. Panel Layout:

a. Follow the USG Structural Panel Concrete Subfloor application described in the current Progressive Engineering, Inc.'s Evaluation Report PER-13067.

3. Acoustical Ratings: Where sound ratings are indicated, provide materials and application procedures identical to those tested by manufacturer to achieve STC in accordance with ASTM E90 and/or Impact Insulation Class (IIC) in accordance with ASTM E989.

B. Roof Deck Systems:
   1. Roof Framing:
      a. Minimum Deflection: L/360.
      b. Uniform Roof Load: 50 lbf/sq. ft. (Ultimate).
      c. Framing Spacing: Maximum 48 inches o.c.
   2. Fasteners: Follow fastener layout for screw patterns and design diaphragm in accordance with "PER-14076."
   3. Panel Layout: Comply with "Structural Panel Concrete Roof Deck" application in accordance with "PER-14076."

C. Fire Resistance Ratings: Where fire resistance classifications are indicated, provide materials and application procedures identical to those listed by UL or tested according to ASTM E119 for type of construction shown.

D. Note: Fire-resistance ratings may require lighter gauge framing than that required for Shear- or Uniform-Loading. In this case, the gauge and joist depth must be selected by the strongest governing factor.

E. Noncombustible Ratings: Where noncombustible assemblies are required, provide materials and application procedures identical to those tested according to ASTM E136.

F. Acoustical Ratings: Where sound ratings are indicated, provide materials and application procedures identical to those tested by manufacturer to achieve Sound Transmission Class (STC) in accordance with ASTM E90 and/or Impact Insulation Class (IIC) in accordance with ASTM E492 specified.

1.07 DELIVERY, STORAGE AND HANDLING

A. Delivery:
   1. Deliver material to site promptly without undue exposure to weather.
   2. Deliver in manufacturer's unopened containers, pallets, or panels fully identified with name, brand, type and grade.

B. Storage:
   1. Store above ground in dry, ventilated space.
   2. Protect materials from soiling, exposure, and damage.
   3. If stored outside, material shall be covered with waterproof tarps.
   4. Panels must be stored over stable soil or other surface. Soil or surface must be

able to carry the load of the stored pallet(s). Each 20-piece pallet weights 3500 lbs. It is recommended that the load carrying capacity of the floor or surface be verified before storing panels.

5. Pallets must not be stacked out of alignment by more than +/- 1/2" (13 mm) , measured on any side of the pallet.

1.08 FIELD CONDITIONS

A. Environmental Requirements:
   1. When mechanically fastened, do not install cementitious-reinforced panels when ambient or conditioned temperature is below 0 deg F (minus 17.8 deg C).
   2. Do not apply finish flooring or roofing over cementitious-reinforced panel when wet, frozen, or containing frost.
   3. Prior to application of finish flooring or roofing, cementitious-reinforced panels and subfloor must be conditioned at same temperature as required for the finished flooring for at least 48 hours.

1.09 PROJECT CONDITIONS

A. Environmental Requirements:
   1. When mechanically fastened, do not install Cementitious-reinforced Structural Panels when ambient or conditioned temperature is below 0 °F (-18 °C).
   2. Prior to the application of finished flooring, Cementitious-reinforced Structural Panels must be conditioned at the same temperature as required for the finished flooring for at least 48 hours.
   3. Do not apply finished flooring over Cementitious-reinforced Structural Panels when wet, frozen or with surface frost.
   4. Note: If installed panels have snow or ice, do not use salts or defrosting agents, sand is recommended over slippery surfaces.

PART 2 – PRODUCTS

2.01 PRODUCTS AND MANUFACTURERS

A. Cementitious-reinforced Structural Panels: Listed products establish standard of quality and are manufactured by United States Gypsum Company (USG), Chicago, IL.

2.02 MATERIALS

A. Structural Concrete Panel:
   1. USG Structural Panel Concrete Subfloor, noncombustible structural subfloor panel manufactured in accordance with Acceptance Criteria ICC-ES AC318 or Architect approved equivalent.
   2. Panel Dimensions:
      a. Thickness: 3/4 inch (19 mm).
      b. Width: 48 inch (1220 mm).
      c. Lengths: 72 inches (1829 mm), 80 inches (2032 mm), or 96 inches (2438 mm)

d. Long Edges: Tongue and Groove.

3. Panel Properties:
   a. Density: 75 lbs./cu. ft. (1200 kg/m3) tested in accordance with ASTM C1185
   b. Weight: 5.0 lbs/ft2 (24.4 kg/m2) tested in accordance with ASTM D1037 at a thickness of 3/4 inch (19 mm).
   c. Concentrated Load: 804 lbf (3.58 kN) when tested in accordance with ASTM E661.
   d. Noncombustibility: Pass tested in accordance to ASTM E136.
   e. Surface Burning Characteristics: 0 - Flame Spread / 0 - Smoke Developed tested in accordance with ASTM E84.
   f. Mold Resistance: 10 when tested in accordance with 1, and 0 when tested in accordance with 2.
   g. ASTM D3273 Termite Resistance: 9.8 when tested in accordance with AWPA E1.

B. Structural Panel Concrete Subfloor Recommended Fasteners:
   1. In accordance with PER-13067 (Subfloor) and PER-14076 (Roof Deck), PER-15092 (Foundation Wall), and ESR-1792 (Subfloor).
   2. Use only fasteners recommended by the approved manufacturer.
   3. Install using the recommended spacing and distance from the Ends (square cut) and Edges (tongue & groove) of the panel.
   4. Fasteners: As recommended by structural panel manufacturer to suit Project. Size and length as recommended unless otherwise specified by the Project structural engineer.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine substrates, adjoining construction and conditions under which Work is to be installed.
   1. Steel framing to receive the Structural Panel Concrete Subfloor shall be structurally sound, free from bows, twists or other malformations and in general compliance with local building code requirements.

B. Do not proceed with Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Hot-Rolled Steel Framing:
   1. The floor joists and other floor framing components must be designed to meet the strength and deflection criteria specified in the contract documents.

2. Framing shape and size is always based on diaphragm capacity.
3. Hot-rolled steel framing shall have a 3” (76 mm) or larger bearing surface suitable for fastener insertion and panels must bear a minimum of 1 1/4” (32 mm) on the framing member.
4. Framing bearing shall be provided at the foundation that is uniform and level.
5. Joist framing must be perpendicular to support beams.
6. Additional framing members shall be provided under parallel partitions and around all floor openings that interrupt one or more spanning members. Framing must be properly fastened to the supporting walls or structure.
7. All blocking or bridging must be installed prior to the installation of USG Structural Panel Concrete Subfloor.
8. Framing must be of good quality, free of bows, twists or other malformations.

B. Structural Panel Concrete Subfloor:
   1. This product may contain respirable crystalline silica. Refer to OSHA Rule 29 CFR 1926.1153 for specific details about limiting worker exposure to respirable silica.
   2. The panels shall be cut to size with a circular saw equipped with carbide-tipped cutting blade and a dry dust industrial HEPA vacuum collection device .for control of dust and silica. Wear safety glasses and a NIOSH-approved dust mask when cutting the panel. Collected dust shall be disposed in a safe manner and in compliance with local, state and federal ordinances.
   3. Structural Panel Concrete Subfloor shall be installed with the long edges (tongue & groove) perpendicular to the framing.
   4. Attachment: Mechanical attachment.
   5. Begin panel installation by snapping a line across the joists parallel to the rim joist at a distance equal to the width of the first panel being placed.
      a. As panel width is 48 inches (1219 mm), plan layout for first and last panel row width to be a minimum 24 inches (610 mm).
      b. Where row width is less than 24 inches (610 mm) wide, support panels on unsupported edges with framing; strapping is insufficient and unacceptable.
   6. Ensure that all supporting members are free of debris before placing panels. Place the cut edge or tongue along the rim joist.
      a. Place each panel across three or more supports [minimum two-span condition].
      b. Cut panels to length as needed to ensure that butt end of panel is centered on framing member.
      c. Install panels in a direction to ensure that butt end falls over open side of joist, to keep adjacent ends in same place.
   7. Fasten panels in accordance with fastening schedule. Begin fastening at one end and fan out across panel. Do not fasten corners first. Structural panel screws are installed in subfloor in accordance with "PER-13067" and "ESR-1793"; roof deck is installed in accordance with "PER-14076."
      a. Install fasteners using structural panel manufacturer's recommended spacing and distance from panel ends (square cut) and edges (tongue and

groove).

b. After installation of one complete row, begin next row. Slide panels together for tongue of panel to fit in groove of panel.
c. Do not force tongue when construction debris is lodged in grove. Clean plugged groove with a stiff bristle brush to dislodge trapped debris.
d. Gapping of panels is unacceptable.
e. Install second and each subsequent panel using same recommended method to complete row.
f. Install rows in a running bond pattern for end joints to fall over center of framing members, staggered by a minimum of two supports from where end joints fall in adjacent rows.
g. Fasten outside corner of first installed panel; progressively fan out fastener installation to adjacent panel edges.

8. Make cutouts prior to installing panels.
   a. If cutouts are required after panel is installed, set depth of saw blade to ensure that framing is not scored.
   b. Support ends and edges of cutouts when framing is 6 inches (152 mm) or more in either direction.
9. Verify that panel is flush with supporting member; drive fastener heads flush with surface.

3.03 CLEANING

A. Remove leftover materials from Project site.

B. Remove foreign materials from surface with broom and vacuum.

3.04 PROTECTION

A. Construction Traffic Protection – Traffic Protection during Construction: In high-traffic areas, install temporary sheathing materials over cementitious-reinforced panels and remove just prior to installing finish materials.

+ + END OF SECTION + +

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SECTION 06164

GYPSUM SHEATHING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Agreement, including General and Division 01 of the Project Manual, apply to work of this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Gypsum sheathing for exterior wall construction.
   2. Gypsum sheathing for exterior soffit construction.

1.03 REFERENCES

A. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.

B. ASTM C1280 - Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing; 2018.

C. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.

D. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.

E. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2020.

F. GA-216 - Application and Finishing of Gypsum Panel Products; 2021.

G. GA-600 - Fire Resistance and Sound Control Design Manual; 2021.

H. GA-253 "Recommended Specifications for the Application of Gypsum Sheathing".

1.04 SUBMITTALS

A. Pursuant to Section 01300 - Submittals.

B. Product Data:
   1. Submit manufacturer's product data for each type of exterior gypsum sheathing indicating where each type will be used.

2. Submit fastener data as recommended by exterior gypsum sheathing manufacturer and as specified herein.

C. Warranty:
   1. Submit sample warranties for all warranty requirements specified in the Warranty paragraph below.

1.05 QUALITY ASSURANCE

A. Experienced workers familiar with the work and according to manufacturer's recommendations and/or industry standards shall perform all work of this section.

B. All work of this section shall conform to industry standards and/or manufacturer's recommendations.

C. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.

D. Fire-Test-Response Characteristics: Where fire-rated gypsum board assemblies are indicated, provide gypsum board assemblies that comply with the following requirements:
   1. Fire Resistance Ratings: As indicated by reference to GA File Numbers in GA-600 "Fire Resistance Design Manual" or design designations in UL "Fire Resistance Directory" or in the listing of another testing and inspecting agency acceptable to authorities having jurisdiction.
   2. Gypsum board assemblies indicated are identical to assemblies tested for fire resistance according to ASTM E119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Pursuant to manufacturers published instructions.

B. All materials shall be delivered in their original unopened packages and stored in an enclosed shelter providing protection from damage and exposure to the elements.

C. Neatly stack gypsum panels flat to prevent sagging.

1.07 WARRANTY

A. Provide products that offer twelve months of coverage against in-place exposure damage (delamination, deterioration and decay).

B. Manufacturer's Warranty:
   1. Five (5) years against manufacturing defects.

PART 2 PRODUCTS

2.01 MATERIALS

A. Gypsum Sheathing - Exterior
   1. Glass-Mat Gypsum Board: Gypsum board designed as an exterior substrate for a weather barrier, consisting of a noncombustible water-resistant core, essentially gypsum, surfaced with glass mats on face and back, partially or completely embedded in core, and with unsurfaced square edges. Comply with ASTM C1177/C1177M and requirements below.
      a. Type: X
      b. Thickness: 5/8 inch
   2. Products: Subject to compliance with requirements, gypsum sheathing boards that may be incorporated in the Work include, but are not limited to, the following:
      a. Dens-Glass® Gold Exterior Sheathing; Georgia-Pacific Gypsum LLC
      b. GlasRoc® Sheathing; CertainTeed
      c. Securock Firecode X Glass Mat Sheathing; U.S. Gypsum Company.
   3. Sheathing fasteners: ASTM C954, steel drill screws, Type S-12 fluted tip, a minimum of 1-¼ inches long with organic polymer coating or other corrosion-protective coating.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.

C. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

D. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.02 SHEATHING INSTALLATION

A. Comply with ASTM C1280, GA-253 and manufacturer's written instructions. Erect gypsum sheathing pursuant to GA-216 and fasten at 6" o.c. along panel edge locations and 12" o.c. field locations with 1 ¼" S #6 screws.
   1. Fasten sheathing to cold-formed metal framing with screws.
   2. Install boards with a 3/8-inch gap where non-load bearing construction abuts structural elements.

3. Install boards with a ¼ inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.

C. Horizontal Installation: Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each stud.
   1. Space fasteners approximately 6 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
   2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
   1. Space fasteners approximately 6 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
   2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

E. Do not bridge building expansion joints; cut and space edges of gypsum sheathing to match spacing of structural support elements.

3.03 PROTECTION

A. Protect gypsum sheathing and gypsum roof board until covered.

B. Replace broken or damaged sheathing.

C. Apply permanent or temporary covering within manufacturer's stated exposure limits.

+ + END OF SECTION + +

SECTION 06820

GLASS FIBER REINFORCED PLASTIC FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glass fiber reinforced, resin fabrications.

B. FRP gratings, support systems and connections.

C. Aeration Tank Baffle Walls.

1.02 REFERENCE STANDARDS

A. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

C. FM (AG) - FM Approval Guide; current edition.

D. ITS (DIR) - Directory of Listed Products; Current Edition.

E. UL (DIR) - Online Certifications Directory; Current Edition.

F. New York State Building Code (NYSBC)

1.03 DESIGN REQUIREMENTS

A. Grating and stair design Live and Dead Loads: 100 lbs/sq ft (690 kPa) or a concentrated load of 300 pounds with deflection limited to 1/360 of span unless noted otherwise on the design drawings.
   1. Grating located in areas of transformer platform shall be designed for a uniform load of 300 lbs/s.f.

B. Molded or pultruded grating and molded stair treads shall not deflect more than ¼" and structural support members shall not deflect more than L/180 of span for structural members unless specifically stated otherwise herein or on drawings. Connections shall be designed to transfer the design loads.

C. Layout: Each grating section shall be readily removable, except where indicated on drawings. Manufacturer to provide openings and holes where located on the contract drawings. Grating openings which fit around protrusions (pipes, cables, machinery,

etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable.

D. Design items with sufficient strength for handling stresses.

E. Temperature exposure is limited to 100°F (38°C) unless specifically stated otherwise.

F. The baffle walls shall be designed for a 12-inch fluid differential and a wind load of 15 pounds per square foot, acting non-simultaneously.

G. The factor of safety for allowable stress shall be 2.0 for baffle panels and 2.5 for structural framing.

H. The allowable deflection of the baffle panels shall be L (or H)/30 and the allowable deflection of the structural framing shall be L (or H)/180.

1.04 SUBMITTALS

A. See Section - 01300 - SUBMITTALS for submittal procedures.

B. Product Data: Provide data on specified component products.

C. Shop Drawings: Indicate design load parameters, dimensions, adjacent construction, materials, thicknesses, fabrication details, required clearances, field jointing, tolerances, connections, colors, finishes, methods of support, integration of plumbing and electrical components, and anchorages.

D. Samples: Submit two samples, 6 x 6 inch (152 x152 mm) in size, illustrating color, texture, and finish.

E. Maintenance Data: Include instructions for stain removal, surface and gloss restoration, and general cleaning recommendations.

F. Stair assembly and Baffle Wall shop drawings shall bear the seal and signature of a registered professional engineer licensed in the state of New York. A full set of signed and sealed calculations affixed with a PE sign and seal shall accompany the shop drawings.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: Design under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in New York.

B. The material covered by these specifications shall be furnished by an ISO-9001:2008 certified manufacturer of proven ability who is regularly engaged in the manufacture, fabrication and installation of FRP systems.

C. Manufacturer Qualifications: Company specializing in architectural glass fiber and resin components with five years documented experience with sufficient production capacity to produce required units without causing delay in the work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. All systems, sub-systems and structures shall be shop fabricated and assembled into the largest practical size suitable for transporting.

B. Protect components from damage by retaining shipping protection in place until installation.

C. Identify and match-mark all materials, items and fabrications for installation and field assembly.

D. All materials and equipment necessary for the fabrication and installation of guardrail/handrail and appurtenances shall be stored before, during, and after shipment in a manner to prevent cracking, twisting, bending, breaking, chipping or damage of any kind to the materials or equipment, including damage due to over exposure to the sun. Any material which, in the opinion of the Architect, has become damaged as to be unfit for use, shall be promptly removed from the site of work, and the Contractor shall receive no compensation for the damaged material or its removal.

1.07 FIELD CONDITIONS

A. Do not install site fabricated components when site conditions may be detrimental to successful installation.

B. Maintain temperature and humidity conditions favorable to proper curing of resin during and after installation.

C. Field verify measurements for stair and railing assemblies that require coordination and consideration to existing and new previously installed construction, including items installed under other prime contracts.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Glass Fiber and Resin Fabrications:
   1. Fibergrate Composite Structures, Inc.; Vi-Corr® molded grating, Fibertred® stair treads and Dynaform SAFRAIL railing systems
   2. Strongwell; DURAGRATE Molded grating and Strongwell Railing system.
   3. Seasafe Fiberglass Grating and Structural Systems by Amico, Gatordeck Pultruded Grating.
   4. Or approved equal.

2.02 REGULATORY REQUIREMENTS

A. Conform to applicable code for a flame/smoke index rating of 25/0 in accordance with ASTM E84 listed product requirements.

2.03 MATERIALS

A. Pultruded FRP Materials:
   1. Materials used in the manufacture of the FRP products shall be raw materials in conformance with the specification and certified as meeting the manufacturer's approved list of raw materials.
   2. All structural shapes are to be manufactured by the pultrusion process with a glass content minimum of 45%, maximum of 55% by weight. The structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
   3. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
   4. The visual quality of the pultruded shapes shall conform to ASTM D4385.
   5. FRP guardrail/handrail shall be manufactured using a pultruded process utilizing vinyl ester resin with flame retardant and ultraviolet (UV) inhibitor additives. Unless a phenolic resin system is utilized, a synthetic surface veil fabric shall encase the glass reinforcement. FRP shapes shall achieve a flame spread rating of 25 or less in accordance with ASTM test method E84, the flammability characteristics of UL 94 V0 and the self-extinguishing requirements of ASTM D635.
   6. FRP products exposed to weather shall contain an ultraviolet inhibitor. Should additional ultraviolet protection be required, a one mil minimum UV coating may be applied. Products manufactured with a phenolic resin system shall be coated with a one mil minimum UV coating.
   7. All exposed railing surfaces shall be smooth and true to form, consistent with ASTM D4385.

Fiberglass Pultruded Material Properties				
Properties	**Test**	**Units**	**Value**	
Tensile Strength	ASTM D790	psi	30,000	
Tensile Modulus	ASTM D638	psi	2.5 x 10^6	

Flexural Strength	ASTM D790	psi	30,000	
Flexural Modulus	ASTM D790	psi	1.8 x 10^6	
Flexural Modulus (Full Section)		psi	2.8 x 10^6	
Short Beam Shear (Transverse)	ASTM D2344	psi	4,500	
Shear Modulus (Transverse)	N/A	psi	4.5 x 10^5	
Coefficient of Thermal Expansion	ASTM D696	in/in/deg F	8.0 x 10^-6	
Flame Spread	ASTM E84	N/A	25 or less	

B. FRP Molded Grating Materials:
   1. All mechanical performance standards set forth by the Fiberglass Grating Manufacturers Council (FGMC) in the FRP Composites Grating Manual for Pultruded and Molded Grating and Stair Treads.
   2. A flame spread rating of 25 or less in accordance with ASTM E84, and flammability characteristics of UL 94 V0 and the self-extinguishing requirements of ASTM E84. (Polyester resin is available without flame retardant and UV inhibitor additives.)
   3. NSF® Standard 61 Certified with flammability characteristics of UL 94 V0 and the self-extinguishing requirements of ASTM E84.
   4. Food-grade with flammability characteristics of UL 94 V0 and the self-extinguishing requirements of ASTM D635.

Resin Systems	
Description	**Resin Base**
Chemical Resistant - Fire Retardant	Vinyl Ester
Industrial Grade - Fire Retardant	Isophthalic
Architectural Grade - Fire Retardant	Orthophthalic
High Temperature – Low Smoke/Low Flame	Phenolic
Low Flame/Class 1 Smoke	Custom Blend

C. FRP Molded Grating System:
   1. Grating shall be reinforced with continuous rovings of equal number of layers in each direction. The top layer of reinforcement shall be no more than 1/8" below the top surface of the grating so as to provide maximum stiffness and prevent resin chipping of unreinforced surfaces. Percentage of glass (by weight) shall not exceed 35% so as to achieve maximum corrosion resistance, and as required to maintain the structural requirements of the CONTRACT.
   2. The FRP molded grating and treads shall be manufactured by the open mold process.

3. Grating shall be 2 inches square mesh with a 2 inch depth with a tolerance of plus or minus 1/16 inch mesh centerline to centerline. Grating shall be a molded type with a meniscus top surface. Color shall be as selected by the Engineer.
4. Grating Pedestal Support System:
    a. Grating pedestals shall be adjustable. Pedestal shall consist of molded bases and tops, with DYNAFORM® pedestals joining the bases and tops and Type 316 stainless steel threaded rods for adjustability.
    b. Pedestals shall be 2-1/8 inches x 3/16 inch square tube as manufactured by the pultrusion process. Adjustability shall be achieved with a 316 stainless steel all-thread component that threads into the molded fittings. Color shall be light gray.
    c. Provide Quad and Single Head Mini Pedestal support heads with retainer clips for grating supports as indicated on the approved manufacturer shop drawings.
    d. Provide Type 316 stainless steel retainer and M saddle clips spaced at maximum of four feet apart with a minimum of four per piece of grating, for each grating connection and anchorage point as recommended by the manufacturer and as indicated on the approved shop drawings.
    e. Design: Pedestal floor system shall be designed for a uniform load of 50 psf or concentrated load of 300 lb. Deflection of supported grating is not to exceed 0.375 inch. Grating pedestals are to be laid out according to the manufacturers published literature or as indicated in the contract drawings.
5. Provide 3 inch x 3 inch x 3/8 inch thick FRP ledge angles as required to mount grates to concrete surfaces. Provide 3/8 inch diameter 316SS Hilti Kwik Bolt TZ anchors stainless steel expansion type epoxy set anchors spaced at 16 inches o.c. maximum or less if required for loading conditions.
6. Provide FRP embedment angles at recessed grating locations as indicated on the drawings. Coordinate provision of theses embedments with the timing of the concrete installations in order to set into formwork prior to concrete installations.
7. Provide manufacturers embedment sleeves / angles for fixed handrails set into the poured concrete flatwork.
8. Molded stairtreads shall be 1-1/2 inches (38.1 mm) thick in a 1-1/2 inches (38.1 mm) x 6 inches (152.4 mm) rectangular mesh pattern. The resin system will be the same as the molded grating. The stairtread shall come complete with anti-slip nosing.
9. Open Area of Grating shall be 60% minimum.
10. Provide accessories for FRP fabrications as indicated on the drawings, recommended by the manufacturer, and required by all authorities having jurisdiction. Provide toe kicks at all FRP gratings that do not terminate against a wall.

D. Steel Framing:
    1. Refer to section 05510 - Metal Stairs and Railings for additional information on stair framing as it relates to FRP stairs.
        a. Fabricate stringers of steel plates or channels tubes or a combination of both as indicated.

b. Provide closures for exposed ends of channel or tube stringers.
c. Construct platforms of steel tube headers and miscellaneous framing members as indicated.
d. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
e. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

2. Refer to drawings and other specification divisions as it relates to steel framing for FRP gratings.

E. Stainless steel fasteners shall consist of threaded rods and nuts and shall be sized by the designer to support all required loads. All fasteners shall be 316 stainless steel.

2.04 FABRICATION

A. Mold Material: Metal type.

B. Mold Surface: Textured to achieve non-slip finish.

C. Finish other surfaces not in contact with the mold to match the molded surfaces in appearance.

D. Finish trim corners and edges.

E. Cure components prior to shipment and remove material that may be toxic to plant or animal life.

2.05 BAFFLE WALL SYSTEM

A. Baffle panels shall be ribbed. Horizontal ribs shall be sloped a minimum of 20 degrees to reduce settlement of sediment of the ribs.

B. Baffle wall system shall be complete including baffle panels, structural framing, and fasteners.

C. Baffle wall system shall be AquaSpan as manufactured by Enduro Composites or Baffle Panel System as manufactured by Strongwell.

2.06 FINISH

A. Color: as selected by the Owner/Architect.

B. Exposed to view Surface Texture: Grating surfaces shall be non-slip..

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work and dimensions are as indicated on shop drawings.

3.02 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.03 INSTALLATION

A. Install fabrications in accordance with shop drawings and fabricator's instructions.

B. Fasten grating panels securely in place with hold down fasteners as specified herein.

C. Fastening to in-place construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous FRP fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors as determined by the Design Engineer.

D. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades for drilling and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment and elevation; with edges and surfaces level, plumb, true and free of rack; measured from established lines and levels.
   1. All field cut and drilled edges, holes and abrasions shall be sealed with a catalyzed resin compatible with the original resin as recommended by the manufacturer.

E. The fabricated handrail sections shall be installed as shown on the approved shop drawings. The handrail sections shall be accurately located, erected plumb and level. The sections shall be fastened to the structure as shown on the approved shop drawings.

3.04 TOLERANCES

A. Maximum variation from true position: 1/4 inch (6 mm).

B. Maximum offset from true alignment: 1/8 inch (3 mm).

3.05 CLEANING

A. Clean components of foreign material without damaging finished surface.

B. Hand rub smooth surfaces with polishing cream.

C. Clean fabrications in accordance with fabricator's instructions.

3.06 PROTECTION

A. Place protective structural covering over installed units.

+ + END OF SECTION + +

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SECTION 07111

BITUMINOUS DAMPPROOFING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install bituminous dampproofing.
   2. Extent of bituminous dampproofing is shown on drawings. If not shown, provide on all below grade walls at a minimum.
   3. Types of products required include the following:
      a. SSPC-Paint 12, cold-applied solvent-type bituminous mastic coating for bituminous separator between dissimilar materials in dry film thickness of 15-mils per coat.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before bituminous dampproofing Work.

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM D1187, Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
   2. ASTM D1227, Specification for Emulsified Asphalt Used as Protective Coating for Roofing.
   3. ASTM D4479, Specification for Asphalt Roof Coatings—Asbestos-Free.
   4. ASTM D4586, Specification for Asphalt Roof Cement, Asbestos-Free.
   5. SSPC-Paint 12, Cold Applied Asphalt Mastic (Extra Thick Film).

1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Installer: Engage a single installer with successful experience installing bituminous dampproofing, and that is acceptable to or licensed by manufacturer of bituminous dampproofing materials, and that employs only workers with specific skill and successful experience in the type of Work required.

B. Component Supply and Compatibility:
   1. Provide all bituminous dampproofing of each type required produced by one manufacturer.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of all Project-specific surfaces where bituminous dampproofing will be applied.
   2. Product Data:
      a. Manufacturer's specifications and technical data for each required dampproofing material. Indicate VOC content of materials proposed.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Submit bituminous dampproofing manufacturer's certification or other data substantiating that materials proposed for use comply with the Contract Documents, and are recommended by bituminous dampproofing manufacturer for the required applications.
      b. Certification indicating that bituminous dampproofing materials delivered in bulk, if any, to the Site comply with the Contract Documents. Include statistical and descriptive data for each product furnished. Submit certificate with each load before using the material in the load.
      c. Certification indicating compliance with Laws and Regulations for air quality regarding maximum VOC content for bituminous dampproofing materials.
      d. Certification that materials furnished is Asbestos-free as required by ASTM D4479 and ASTM D4586.
   2. Supplier's Instructions:
      a. Manufacturer's instructions for handling and storing.
      b. Manufacturer's instructions for application methods and application procedures.
   3. Qualifications Statements:
      a. Installer: Submit copy of manufacturer's acceptance of installer and installer's record of experience in work similar to that required under this Section.

1.05 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver bituminous dampproofing bulk shipments in original, unopened, undamaged containers with manufacturer's certification indicating compliance with the Contract Documents.
   2. Do not store damaged or opened containers at the Site. Remove from Site and do not offer such damaged material again.
   3. Include with each bulk shipment information on the material's shelf-life, date, quantity delivered, and other information as may be required to establish acceptability of materials delivered to the Site.

B. Storage of Materials:
   1. Store emulsions at temperatures above 40 degrees F.

C. Handling of Materials:
   1. Do not open containers or mix components until preparatory Work is completed.
   2. Do not use solvent-based bituminous dampproofing without adequate ventilation. Prevent build-up of explosive and hazardous fumes.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Do not install bituminous dampproofing when ambient air temperature is 40 degrees F or less.
   2. Do not apply bituminous dampproofing materials to frozen substrates or to substrate in condition not complying with bituminous dampproofing material manufacturer's recommendations.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General:
   1. For interior and concealed-in-wall uses, provide bituminous dampproofing material that is odor-free after drying for 24 hours.

B. Cold-Applied, Cut-Back Asphalt Dampproofing:
   1. Asphalt Compound: Manufacturer's standard asphalt and cut-back solvent-based compound with mineral stabilizers, recommended for concealed in cavity wall interior applications, compounded to penetrate the substrate and build to a moisture-resistant, firm, elastic coating.
   2. Heavy-Fibrated, Short-Fibered Dampproofing Material:
      a. Provide heavy-fibrated, short-fibered type, spray- or brush-applied mastic dampproofing compound complying with ASTM D4479, Type I.
      b. Products and Manufacturers: Provide one of the following:
         1) Hydrocide Semimastic, by ChemRex, Inc., Sonneborn Building Products Division.
         2) Karnak 83 AF Fibered Dampproofing, by Karnak Chemical Corporation.
         3) Or equal.

C. Cold-Applied Asphalt Protective Coating:
   1. Asphalt Emulsion: Complying with MIL-C-16173D Type I and Federal Specification TT-C-494B Type II, except containing no asphalt fibers.
   2. Bituminous Paint:
      a. Products and Manufacturers: Provide one of the following:
         1) Karnak 118 Black Asphalttum, by Karnak Chemical Corporation.
         2) Hi-Mill Sher Tar Epoxy, by Sherwin Williams.
         3) Elasto-Mulsion A300, by Pacific Polymers.

PART 3 – EXECUTION

3.01 INSPECTION

A. Examine the substrates and conditions under which bituminous dampproofing Work will be applied, and advise Architect in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. General:
   1. Do not proceed with bituminous dampproofing Work until blocking, nailers, piping, conduits, and other projections through the substrate are installed, with substrate properly patched and sealed or flashed to receive the bituminous dampproofing.

B. Surface Preparation:
   1. Remove from the substrate dirt, oil, loose materials, and other substances that interfere with penetration, bond, and performance of bituminous dampproofing materials.
   2. Dampen with water surfaces that are dry and are to receive application of bituminous dampproofing. Keep such surfaces damp ahead of application.

3.03 INSTALLATION

A. Cold-Applied, Cut-Back Bituminous Dampproofing on Cavity Wall:
   1. Prime the substrate when recommended by bituminous dampproofing manufacturer's instructions, using the type and quantity of primer recommended by bituminous dampproofing manufacturer.
   2. Cold-Applied, Non-fibrated Liquid Dampproofing:
      a. Apply coating of cold-applied, non-fibrated liquid bituminous dampproofing material by brushing or spraying at the rate of one gallon per 80 square feet to produce uniform dry film thickness of not less than 12 mils.
      b. After first coat has dried for not less than 24 hours, repeat the application. Apply second coat at rate of one gallon per 120 square feet. Apply second coat at right angles to first coat.

B. Cold-Applied Bituminous Paint for dissimilar metals:
   1. Apply bituminous paint to property prepared concealed unpainted surfaces in contact with dissimilar metals, cementitious materials, masonry, and wood.
   2. Coat surfaces with 2 coats of bituminous paint for a minimum of 16 mils DFT or as recommended by coating manufacturer.
   3. Dipping of aluminum into bituminous paint is not permitted. Allow bituminous paint to dry prior to installation of aluminum component.

3.04 PROTECTION OF EXECUTED WORK

A. Protect other work from spillage of bituminous dampproofing materials, and prevent such materials from penetrating and clogging drains, conductors, and other utilities.

B. Remedy damage to other construction that is soiled or otherwise damaged during installation of bituminous dampproofing.

+ + END OF SECTION + +

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SECTION 07140

FLUID APPLIED WATERPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES:

A. Fluid Applied Waterproofing for use on exterior exposed concrete slabs.
   1. Evaluation/Preparation of Substrate to Receive Vehicular Traffic Waterproofing
   2. Epoxy Primer Application
   3. Poly(methyl methacrylate)-based (PMMA) Primer Application
   4. Poly(methyl methacrylate)-based (PMMA) Vehicular Traffic Waterproofing Membrane Application
   5. PMMA Flashing Application

1.02 RELATED SECTIONS.

A. Section 03300 - Cast-in-Place Concrete

B. Section 07920 - Joint Sealers

1.03 REFERENCE STANDARDS.

A. Agencies which may be used as references throughout this specification section include:
   1. National Institute for Occupational Safety & Health, Atlanta, GA.
   2. Occupational Safety and Health Administrations, Washington, DC
   3. International Concrete Repair Institute, Sterling, VA
   4. American Concrete Institute, Farmington Hills, MI

1.04 SUBMITTALS

A. Product Data: Submit manufacturer’s product data, use limitations and recommendations.
   1. Submit manufacturer's installation drawings for all areas requiring special detailing i.e. penetrations thru waterproofing, inside corners, outside corners, top of wall terminations, etc.
   2. Submit manufacturer's statement of compatibility with concrete mix including admixtures.

B. Installation Instructions: Submit manufacturer's written installation instructions including any temperature or other environmental restrictions.

C. Samples: Submit three (3) representative samples of the following for approval:

1. Fluid applied membrane. (Cured 6" x6" sample on a substrate (wood is acceptable))
2. Prefabricated drainage composite.

D. Warranty: Submit sample warranty meeting the requirements specified in the "Warranty" paragraph below.

1.05 QUALITY ASSURANCE

A. Acceptable Contractor: Contractor shall be certified in writing by the waterproofing materials manufacturer to install the primary waterproofing products.

B. Product Quality Assurance Program: Primary waterproofing materials shall be manufactured under a quality management system that is monitored regularly by a third party auditor under the ISO 9001 audit process.

C. Project Acceptance: Submit a completed manufacturer's application for waterproofing guarantee form along with shop drawings of areas to receive waterproofing, showing all dimensions, penetrations, and details. The form shall contain all the technical information applicable to the project. The project must receive approval by the membrane manufacturer, through this process, prior to shipment of materials to the project site.

D. Scope of Work: The work to be performed under this specification section shall include, but is not limited to, the following: Attend necessary job meetings and furnish competent and full time supervision, experienced mechanics, all materials, tools, and equipment necessary to complete, in an acceptable manner, the waterproofing system installation in accordance with this specification. Comply with the latest written application instructions of the manufacturer of the specific waterproofing products.

E. Local Regulations: Conform to regulations of public agencies, including any specific requirements of the city and/or state of jurisdiction.

F. Manufacturer Requirements: The primary materials manufacturer shall provide trained company personnel to attend necessary job meetings, perform periodic inspections as necessary, and conduct a final inspection upon successful completion of the project.

1.06 PRODUCT DELIVERY STORAGE AND HANDLING

A. Delivery: Deliver materials in the manufacturer's original sealed and labeled containers and in quantities required to allow continuity of application.

B. Storage: Store closed containers in a cool, dry, well ventilated area away from heat, direct sunlight, oxidizing agents, strong acids, and strong alkalis. Keep products away from open fire, flame or any ignition source. Store temperature sensitive products at temperatures recommended by the manufacturer. Quartz silica (sand) must be kept dry during storage and handling.

C. Damaged Material: Any materials that are found to be damaged or stored in any manner other than stated above will be rejected, removed and replaced at the Contractor's expense.

D. Handling: Handle all materials in such a manner as to preclude damage and contamination with moisture or foreign matter. Keep away from open fire, flame, or any ignition source. Vapors may form explosive mixtures with air. Avoid skin and eye contact with this material. Avoid breathing fumes. Do not eat, drink, or smoke in the application area. Workers shall wear long sleeve shirts, long pants and work boots. Workers shall wear butyl rubber or nitrile gloves when mixing or applying this product. Safety glasses with side shields shall be used for eye protection. Use local exhaust ventilation to maintain worker exposure below TLV as listed on MSDS for respective products. If the airborne concentration poses a health hazard, becomes irritating or exceeds recommended limits, use a NIOSH approved respirator in accordance with OSHA Respirator Protection requirements under 29 CFR 1910.134. The specific type of respirator will depend on the airborne concentration. A filtering face piece or dust mask is not acceptable for use with this product if TLV filtering levels have been exceeded.

1.07 PROJECT/SITE CONDITIONS

A. Requirements Prior to Job Start
   1. Notification: Give a minimum of 5 days notice to the Owner and manufacturer prior to commencing any work and notify both parties on a daily basis of any change in work schedule.
   2. Safety: Familiarize every member of the application crew with safety regulations recommended by OSHA and other industry or local governmental groups.

B. Environmental Requirements
   1. Precipitation: Do not apply materials during precipitation or in the event there is a probability of precipitation during application. Take adequate precautions to ensure that materials, applied membrane, and building interiors are protected from possible moisture damage or contamination.
   2. Temperature Restrictions – Epoxy and PMMA-based Materials: Do not apply resin materials if there is a threat of inclement weather. Follow the resin manufacturer's specifications for minimum and maximum ambient, material, and substrate temperatures. Do not apply resin materials unless ambient and substrate surface temperatures fall within the resin manufacturer's published range.

C. Protection Requirements
   1. Protection: Provide protection against staining and mechanical damage for newly applied waterproofing and adjacent surfaces throughout this project.
   2. Limited Access: Prevent access by the public to materials, tools, and equipment during the course of the project.
   3. Debris Removal: Remove all debris daily from the project site and take to a legal dumping area authorized to receive such materials.

4. Site Condition: Complete, to the Owner's satisfaction, all job site clean-up including building interior, exterior, and landscaping where affected by the construction.

1.08 GUARANTEE/WARRANTY

A. Guarantee – Reinforced Systems: Upon successful completion of the project, and after all post installation procedures have been completed, furnish the Owner with the manufacturer's 20 year materials and labor guarantee.
   1. 20-year manufacturers standard waterproofing guarantee for reinforced systems.

PART 2 PRODUCTS

2.01 DESCRIPTION OF SYSTEMS

A. Vehicular Traffic Liquid Applied Waterproofing System: A fleece reinforced, fluid-applied, self-leveling, PMMA-based waterproofing system for use over concrete substrates to receive vehicular or pedestrian traffic. The system shall have an aggregate surfacing and colored abrasion resistant top-coat as selected by owner/specifier from the manufacturer's standard palette of colors.
   1. Basis-of-Design: Siplast Terapro VTS Reinforced Vehicular Waterproofing System, or approved equal.

2.02 WATERPROOFING MATERIALS

A. Epoxy Primer: A high-density, two-component, single-coat, liquid applied, epoxy-based primer for use over concrete in horizontal and vertical applications.
   1. Pro Primer E by Siplast; Irving, TX, or approved equal.

B. PMMA Primer: A PMMA-based primer for use over concrete in vertical applications, concrete repair materials, masonry, wood and plywood.
   1. Pro Primer W by Siplast; Irving, TX, or approved equal.

C. PMMA Primer: A PMMA-based primer for use over horizontal concrete substrates.
   1. Pro Primer T by Siplast; Irving, TX, or approved equal.

D. Flashing Resin: A thixotropic, flexible, acrylic, PMMA-based resin for use in combination with a fleece fabric to form a monolithic, reinforced flashing membrane used in conjunction with a reinforced or unreinforced waterproofing system.
   1. Terapro Flashing Resin by Siplast; Irving, TX, or approved equal.

E. Base Resin: A flexible, acrylic PMMA-based resin for use as waterproofing in a reinforced waterproofing system.
   1. Terapro Base Resin by Siplast; Irving, TX, or approved equal.

F. Fleece: A non-woven, needle-punched polyester fabric used as a reinforcement in PMMA-based flashing and field membrane systems.

1. Nominal Thickness: 40 mils (1 mm)
2. Weight: 110 grams per square meter
3. Pro Fleece by Siplast; Irving, TX, or approved equal.

G. Waterproofing/Wearing Layer Resin: A PMMA-based resin combined with aggregate filler to provide a wearing layer in a reinforced system.
   1. Terapro VTS Resin by Siplast; Irving, TX, or approved equal.

H. Aggregate Filler for Waterproofing/Wearing Layer Resin: A quartz aggregate blend/filler added to the waterproofing/wearing layer resin to produce a PMMA-based resin/aggregate slurry waterproofing/wearing layer.
   1. Terapro VTS Aggregate Filler by Siplast; Irving, TX, or approved equal.

I. Color Finish: A pigmented, multi-component, PMMA-based resin for use as both an embedment and finish layer in waterproofing and flashing systems.
   1. Pro Color Finish by Siplast; Irving, TX, or approved equal.

2.03 WATERPROOFING ACCESSORIES

A. Cleaning Solution/Solvent: A clear solvent used to clean and prepare transition areas of in-place catalyzed resin to receive subsequent coats of resin and to clean substrate materials to receive resin.
   1. Pro Prep by Siplast; Irving, TX
   2. Pro Prep M by Siplast; Irving, TX
   3. Or approved equal.

B. Paste: A flexible PMMA-based paste used for remediation of depressions in substrate surfaces prior to the application of the waterproofing system or used as a leveling layer at fleece overlaps of reinforced waterproofing systems.
   1. Pro Paste by Siplast; Irving, TX, or approved equal.

C. Repair Mortar: A two-component, PMMA-based, aggregate filled mortar used for patching concrete substrates.
   1. Pro Repair Mortar by Siplast; Irving, TX, or approved equal.

D. Catalyst: A peroxide-based reactive agent used to induce curing of PMMA-based resins.
   1. Pro Catalyst Liquid by Siplast; Irving, TX
   2. Pro Catalyst Powder by Siplast; Irving, TX
   3. Or approved equal.

E. Natural Quartz: A natural-colored, kiln-dried, silica aggregate suitable for broadcast into the wearing layer of the vehicular traffic waterproofing system and subsequently coated with a color finish. Quartz shall be supplied by the manufacturer of the waterproofing membrane.
   1. VTS Quartz by Siplast; Irving, TX, or approved equal.

F. Thixotropic Agent: A liquid additive used to increase the viscosity of the PMMA-based resin products, allowing the resins to be applied over vertical or sloped substrates.
   1. Pro Thixo by Siplast; Irving, TX, or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. General: Verify that the substrate is suitable to receive work. Notify the Architect/Engineer in writing of conditions detrimental to the proper and timely completion of work. Bring substrate deficiencies into an acceptable condition prior to commencing work.

B. Concrete Substrate Requirements: Structural concrete shall be cured a minimum of 28 days in accordance with ACI-308, have a minimum compressive strength of 3,500 psi (24 N/mm2) and have a moisture content that conforms with the waterproofing system manufacturer's requirements prior to commencement of work.
   1. Lightweight structural concrete or concrete that does not provide bottom-side venting is not a suitable substrate for direct application of the waterproofing system materials.
   2. Curing compounds containing waxes, oils, silicones or other materials that may inhibit adhesion of the waterproofing system should not be used.

C. Moisture Content Evaluation: Evaluate the level of moisture in the concrete substrate to determine that the moisture content is acceptable for application of the specified waterproofing system and to determine primer application rates. Concrete substrates to receive PMMA-based primers shall have a maximum internal relative humidity of 75% when tested in in accordance with ASTM F1869 and release a maximum of 3 lb of moisture 1000 ft² of surface area per 24-hour period when tested in in accordance with ASTM F2170.

D. Adhesion Testing for Concrete Substrates to Receive Resin Materials: Test the concrete substrate using a device conforming to ASTM D7234 (50 mm dolly) adhered with the specified catalyzed PMMA-based primer. Utilize the same concrete preparation methods as that which will be used prior to application of the waterproofing for areas to be evaluated for adhesion. Ensure that a minimum adhesion value of 220 psi is obtained before application of the PMMA-based primer. If multiple areas or substrates are involved in the scope of work, evaluate each to determine suitability. Maintain testing/evaluation records.

3.02 SURFACE PREPARATION

A. Protection: Provide protection to prevent dust/debris accumulation, spillage and resin overruns.

B. Taping: Utilize masking tape at perimeters and joints of the area to be waterproofed to provide neat terminations.

C. Preparation of Newly Placed Concrete Substrates to Receive Epoxy Primer: Newly placed concrete shall be cured a minimum of 28 days in accordance with ACI-308, and have a minimum compressive strength of 3,500 psi (24 N/mm2). Following evaluation for moisture content and confirmation that the moisture content is at an acceptable level, shot-blast or scarify/shot blast the surface to provide a sound substrate free from laitance and to generate a concrete surface profile of CSP-3 as defined by the ICRI. Grinding may be used as a preparation method for localized areas that cannot be reached by a shot blasting equipment provided that a surface profile of CSP-3 can be generated.

D. Preparation of Existing Concrete/Masonry Substrates to Receive PMMA-based Primer: Existing concrete substrates shall have a minimum compressive strength of 3,500 psi (24 N/mm2). Following evaluation for moisture content and confirmation that the moisture content is at an acceptable level, shot blast or scarify/shot-blast concrete or masonry surfaces to provide a sound substrate free from laitance, carbonated concrete, residue from bitumen, coal tar, primer, coatings, adhesives, sealer or any material that may inhibit adhesion of the specified primer. Generate a concrete surface profile of CSP-4 as defined by the ICRI. Grinding may be used as a preparation method for localized areas that cannot be reached by a shot blasting equipment provided that a surface profile of CSP-4 can be generated.

E. Repair and Leveling of Concrete to Receive Resin Materials: Before application of the waterproofing membrane, and after priming, fill all joints, cracks, voids, fractures, depressions, small indentations, and low areas in the substrate using the specified paste or repair mortar.

F. Concrete Substrate Repair: Prime areas of the prepared concrete substrate intended for repair using the specified PMMA-based primer. Fill the areas using the specified paste or repair mortar and allow to cure. Follow the paste or repair mortar manufacturer's published minimum and maximum product thickness limitations per lift.

G. Crack Preparation: Remove foreign materials from cracks and chase using appropriate equipment to bring the exposed concrete surfaces into a condition suitable to receive the primer. Apply the specified primer to vertical walls of prepared cracks using a brush or other method to avoid overapplication. Allow the primer to cure. Fill cracks using the specified preparation paste, striking the paste flush, and allow it to cure.

3.03 PRIMER MIXING AND APPLICATION

A. Mixing Epoxy Primer: Pierce a hole through the rubber membrane in the lid and continue through the bottom of the lid-well. Ensure that the liquid in the upper reservoir fully drains into the lower reservoir. Remove the upper reservoir and stir mixture for 5 minutes using a Jiffy Mixer at approx. 300 rpm to generate a homogenous, streak-free consistency. Keep the mixer blades fully submerged to avoid

trapping air. Ensure that the bottom and sides of the container are fully scraped to disperse any materials that may have settled. Pour the mixed material into a clean, secondary container and mix again for an additional 30 seconds.

B. Application of Epoxy Primer: Apply the epoxy mixture using a squeegee or 3/8" nap roller using methods provided by, and at the rate specified by the supplier/manufacturer. Scrub the epoxy into the open concrete surface using a brush recommended by the supplier/manufacturer. Cross-hatch using a 3/8" nap roller to generate full, even coverage. Vertical or sloped substrates will require a second coat. Apply primer while substrate and ambient temperatures are falling rather than rising to minimize the potential for pinhole formation. Allow the epoxy system to cure for a minimum 12-hours. Inspect the cured primer surface to ensure that coverage is full and free from dry spots and pinholing. The epoxy system must be overlaid with the PMMA waterproofing/surfacing system within 48-hours of application. When calculating application rates, make allowances for saturation of roller covers and application equipment.

C. Mixing and Catalyzing PMMA Primers: Thoroughly mix the entire drum of uncatalyzed resin for 2-minutes if pouring the resin into a second container when batch mixing. Catalyze only the amount of material that can be used within its pot life. Add pre-measured catalyst to the resin component and stir for 2-minutes using a slow-speed mechanical agitator or mixing stir stick. The amount of catalyst added is based on the weight of the resin used. Refer to the waterproofing system manufacturer's literature for mixing ratios.

D. Application of PMMA Primer: Using the appropriate primer, apply using a 1/2" nap roller at the rate specified by the primer manufacturer to qualified/prepared substrates. Apply primer when ambient and substrate temperatures are falling rather than rising to minimize the potential for pinhole formation. Apply and allow it to cure for a minimum of 45 minutes. Increase application rates over absorbent substrates. Inspect the cured primer surface to ensure that coverage is full and free from dry spots and pinholing. Do not let the resin pool or pond. Do not over-apply primers as this may interfere with proper primer catalyzation. When calculating application rates, make allowances for saturation of roller covers and application equipment.

3.04 VEHICULAR TRAFFIC LIQUID APPLIED WATERPROOFING INSTALLATION

A. Mixing and Catalyzing of PMMA Resins: Thoroughly mix the entire drum of uncatalyzed resins for 2 minutes if pouring the resin into a second container when batch mixing. Catalyze only the amount of material that can be used within its pot life. Add pre-measured catalyst to the resin component and stir for 2-minutes using a slow-speed mechanical agitator or mixing stir stick. The amount of catalyst added is based on the weight of the resin used. Refer to the waterproofing system manufacturer's literature for mixing ratios.

B. Mixing and Catalyzing of Waterproofing Resin/Aggregate Filler Blends: Thoroughly mix the entire drum of uncatalyzed resin and slowly add the amount of filler specified

by the waterproofing system manufacturer. Once the filler has been mixed into the resin component, add pre-measured catalyst to the resin/filler mixture and stir for 2-minutes using a slow-speed mechanical agitator. The amount of catalyst added is based on the weight of the resin used. Refer to the waterproofing system manufacturer's literature for mixing ratios.

C. Dynamic Crack and Control Joint Treatment - reinforced systems: Wipe the previously applied primer and paste using the specified cleaning solution in areas having a 7 inch width centered over the crack. Apply a base coat of catalyzed flashing resin to the prepared substrate with a roller at the minimum rate specified by the resin manufacturer. Extend the catalyzed resin 1/8 inch beyond where the fleece reinforcement will be placed. Embed 6 inch wide strips of the specified fleece reinforcement into the wet/, catalyzed flashing resin using a roller or brush to fully embed the fleece and remove trapped air. Apply an additional coat of catalyzed flashing resin between layers of overlapping fleece. Overlap fleece a minimum 2 inches (50 mm). Apply a finish coat of catalyzed flashing resin immediately following the embedment of the fleece with a roller or brush at the minimum rate specified by the resin manufacturer, ensuring full saturation of the fleece reinforcement.

D. Flashing Membrane Application: Complete flashing application prior to the waterproofing membrane application in the field of the area. Using masking tape, mask the perimeter of the area to receive the flashing system. Pre-cut fleece to ensure a proper fit at transitions and corners prior to flashing membrane application. Apply a base coat of catalyzed flashing resin to the substrate with a roller or brush at the minimum rate specified by the resin manufacturer. Extend the catalyzed flashing resin 1/8 inch (3 mm) beyond where the fleece reinforcement will be placed. Embed the specified fleece reinforcement into the wet, catalyzed flashing resin base coat using a wet, but not saturated, roller or brush to remove trapped air. Overlap the fleece a minimum of 2 inches (51 mm). Apply an additional coat of catalyzed flashing resin between layers of overlapping fleece. Apply a finish coat of catalyzed flashing resin immediately following the embedment of the fleece with a roller or brush at the minimum rate specified by the resin manufacturer, ensuring full saturation of the fleece reinforcement. Remove the tape before the catalyzed resin sets. Make allowances for saturation of roller covers and application equipment when calculating resin quantities. Allow to cure for a minimum of 45 minutes.

E. Fleece Reinforced Waterproofing System Application
   1. Using cleaner/solvent, wipe flashing membrane and primer surfaces to receive the field membrane. Allow the surface to dry for a minimum 20 minutes before continuing work.
   2. Using a roller, apply a layer of catalyzed base resin over the primed substrate at the minimum rate specified by the resin manufacturer. Embed the fleece reinforcement into the wet, catalyzed base resin waterproofing layer using a wet, but not saturated, roller to remove trapped air. Overlap side and end laps of the fleece a minimum of 2 inches (51 mm). Apply an additional coat of catalyzed base resin between layers of overlapping fleece. Apply a second coat of catalyzed

resin immediately following the embedment of the fleece with an application roller or brush at the minimum rate specified by the resin manufacturer, ensuring full saturation of the fleece reinforcement. Allow to cure for a minimum of 45 minutes before application of the wearing layer of resin.

3. Apply a layer of catalyzed waterproofing resin/aggregate filler mixture using a stub roller or trowel at the minimum rate specified by the waterproofing system manufacturer. Use a spiked roller to remove trowel marks and to even the application of the waterproofing resin/aggregate filler mixture.
4. Immediately broadcast quartz into the wet resin/aggregate filler mixture to refusal. Allow to cure for 2 hours. Sweep excess quartz from the surface.
5. Install color finish using a roller or squeegee at the rate specified by the resin manufacturer.
6. Make allowances for saturation of roller covers and application equipment when calculating resin application rates.
7. If work is interrupted for more than 12 hours, or the surface of a catalyzed resin layer becomes dirty or contaminated from exposure to the elements, thoroughly clean the area with cleaner/solvent. Allow a minimum of 20 minutes for the solvent to evaporate before continuing work. Complete the next application procedure within 60 minutes following the evaporation of the cleaner/solvent.

3.05 FIELD QUALITY CONTROL AND INSPECTIONS

A. Site Condition. All areas around job site shall be free of debris, waterproofing materials, equipment, and related items after completion of job.

B. Notification Of Completion: Contractor shall notify manufacturer by means of manufacturer's printed Notification of Completion form of job completion in order to schedule a final inspection date.

C. Final Inspection: Hold a meeting at the completion of the membrane application attended by all parties that were present at the pre-job conference. A punch list of items required for completion shall be compiled by the Contractor and the manufacturer's representative. Complete, sign, and mail the punch list form to the manufacturer's headquarters.

D. Issuance Of The Guarantee. Complete all post installation procedures and meet the manufacturer's final endorsement for issuance of the specified guarantee.

+ + END OF SECTION + +

SECTION 07210

BUILDING INSULATION

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Intent of the work of this section is to provide a continuous and uninterrupted insulated thermal envelope.
   2. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install building insulation.
   3. Extent of each type of building insulation is shown and indicated in the Contract Documents.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before building insulation Work.

C. Related Sections:
   1. Section 03300, Cast In Place Concrete
   2. Section 04220, Concrete Unit Masonry

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM C177, Test Methods for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   2. ASTM C203, Test Method for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
   3. ASTM C236, Test Methods for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box.
   4. ASTM C272, Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
   5. ASTM C303, Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
   6. ASTM D449, Standard Specification for Asphalt Used in Dampproofing and Waterproofing.
   7. ASTM C518, Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   8. ASTM C578, Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   9. ASTM C665, Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
   10. ASTM C764, Specification for Mineral Fiber Loose-Fill Thermal Insulation.

11. ASTM D779, ASTM D779, Standard Test Method for Water Resistance of Paper, Paperboard, and Other Sheet Materials.
12. ASTM D696, Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30 Degrees C and 30 Degrees C with a Vitreous silica dilatometer.
13. ASTM D1621, Test Method for Compressive Properties of Rigid Cellular Plastics.
14. ASTM D2126, Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
15. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.
16. ASTM E96, Test Methods for Water Vapor Transmission of Materials.
17. ASTM E119, Test Methods for Fire Tests of Building Construction and Materials.
18. UL 1479, Fire Tests of Through-Penetration Firestops.

1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturers:
      a. Obtain building insulations, requiring hydrochlorofluorocarbon blowing agent from manufacturer(s) that manufacture product required using blowing agent acceptable for use until the year 2020 and complying in all respects with Copenhagen Amendments to the Montreal Protocol.
      b. Manufacturer shall provide complete technical services including preparation and review of Shop Drawings and submittals, installation methods, and proposed detailing for the Work.
   2. Installer: Engage single installer for each type of building insulation. Each installer shall be skilled, trained, and have record of successful experience in applying and installing each product, and possess successful record of performing work in accordance with recommendations and requirements of manufacturer or that can submit written evidence of being acceptable to manufacturer for providing the required Work. Installers shall employ only tradesmen with specific skill and successful experience in each type of Work required. Submit to Engineer name and qualifications of each installer with the following information for at least three successful, completed projects per installer:
      a. Names and telephone numbers of owner and architect or engineer responsible for each project.
      b. Approximate contract cost of the building insulation system installed.
      c. Quantity (area) of building insulation installed.

B. Regulatory Requirements: Comply with code interpretations by authorities having jurisdiction at the Site.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:

a. Drawings showing extent of the building insulation Work, location of each type of insulation, R-values, thicknesses, and all details required for the Work including connection to building construction and with other types of insulation, referencing system components provided as Samples.
b. Complete selection of fire stop manufacturer's recommended systems for each condition and kind of penetration encountered in the Work. Coordinate with equipment manufacturers for required number and kind of penetrations through fire-rated construction. Provide schedule of penetrations and fire stop system to be included for each condition and kind of penetration encountered.

2. Product Data:
a. Material specifications and general recommendations from building insulation manufacturer for each type of building insulation product. Include manufacturer's data substantiating that materials comply with Contract Documents.
b. Test Reports: Copies of reports of tests on materials being furnished or previously-manufactured, identical materials verifying compliance with physical properties and environmental features specified in the Contract Documents. When requested by Engineer, submit qualifications and summary of experience of testing agencies in performing tests similar to those required.

B. Informational Submittals: Submit the following:
1. Manufacturer's Instructions: Manufacturer's installation instructions. Indicate by copy of transmittal form that installer has received copy of manufacturer's installation instructions.
2. Site Quality Control Submittals: Submit results of specified Site quality control tests.

1.05 DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling of Materials:
1. Do not deliver insulation materials to the Site before the time of installation.
2. Deliver materials in sufficient quantities to allow uninterrupted continuity of the Work.
3. Handle materials carefully to avoid damage and breakage or compressing of boards to less than their specified thickness, or other damage.
4. Handle materials in manner that prevents inclusion of foreign materials.

B. Storage of Materials:
1. Store materials in dry, enclosed area, off ground and away form possible contact with water, ice, and snow.
2. Prevent damage to materials during storage, including minimizing the time materials are stored at the Site before being incorporated into the Work. Store only sufficient quantity of building insulation materials at the Site required for continuous advancement of the Work without causing delay.

1.06 SITE CONDITIONS

A. Environmental Conditions:
   1. Complete the installation and concealment of building insulation materials as rapidly as possible to avoid damage from adjacent construction operations and adverse weather conditions.
   2. Install building insulations when weather and temperature conditions comply with building insulations manufacturers' written recommendations.
   3. Install building insulations when damaging environmental condition are not forecasted for the time when exposed systems materials components would be exposed to potential damage from the elements.
   4. Protect building insulation Work from precipitation, frost, and direct sunlight.
   5. Do not apply pressure-sensitive tape when temperature is below 35 degrees F or above 110 degrees F.
   6. Record decisions, conditions, and agreements to proceed with the Work when weather conditions may be unfavorable. State reasons for proceeding, along with names of persons involved, and changes or revisions (if any), if required, to allow the Work to proceed.

1.07 SCHEDULING

A. Proceed with building insulation Work when preceding Work is ready to receive the Work of this Section.

B. Proceed with building insulation and associated Work after curbs, blocking, substrate board, nailer strips, vents, drains and other projections through the substrates have been installed, and when substrate construction and framing of openings is complete.

C. Proceed with and complete the Work when materials, equipment and tradesmen required for the installation of building insulation and backfilling operations are at the Site and ready to follow with the Work in manner that does not leave the Work vulnerable to damage or deterioration.

D. Do not advance installation of building insulation beyond that necessary for proper sequencing of the Work. Do not advance the Work when there is no proper and secure protection from damaging weather and construction activities.

PART 2 – PRODUCTS

2.01 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. Thermal Conductivity: Thicknesses shown are for thermal conductivity, k-value at 75 degrees F, specified for each material.
   2. Provide adjusted thicknesses based on thicknesses shown or specified for building insulations, as required to comply with required thermal resistances for material having different thermal conductivity.

2.02 MATERIALS

A. Foam Plastic Insulations: Provide the following types:
   1. General: Rigid, closed-cell, thermally stabilized, extruded, hydrochlorofluro-carbon blown, foam board insulation consisting of 100 percent virgin extruded polystyrene modified resin complying with ASTM C578.
   2. Provide blowing agent with lowest available ozone depletion potential, such as HCFC-142b or better. HCFC-141b is not acceptable.
   3. Perimeter Foundation Insulations: Provide very high-load-resisting, rigid foam board insulation complying with ASTM C578, Type VI.
      a. Physical Properties: Provide the following:
         1) Thermal Conductivity (k), ASTM C177 and ASTM C518: 0.20 Btu/inch/hour/square foot/degree F.
         2) Compressive Strength (psi at five percent deformation) ASTM D1621: 40 psi minimum.
         3) Flexural Strength, ASTM C203: 60 psi minimum.
         4) Coefficient of Thermal Expansion, ASTM D696: 3.5x105 inches/inch/degree F.
         5) Water Absorption, ASTM C272: Less than 0.1 percent by volume maximum.
         6) Water Vapor Permeance, ASTM E96: 0.3 to 0.8 perms/inch maximum.
         7) Flame Spread, ASTM E84: Five.
         8) Smoke Developed, ASTM E84: 165 maximum.
      b. Thickness: 1 layer each two inches thick.
      c. Width: 2.0 feet.
      d. Length: 8.0 feet.
      e. Products and Manufacturers: Provide one of the following:
         1) STYROFOAM 40 HIGH LOAD by the Dow Chemical Company.
         2) Foamular 400 by Owens-Corning Fiberglass Corporation.
         3) Or equal.

B. Mineral Fiber Insulation: Provide the following types:
   1. General: Provide insulations formed from inorganic mineral fiber extrusions spun at 2,500 degrees F complying with ASTM C665 and ASTM C764.
   2. Safing Insulation: Provide unfaced semi-rigid non-asbestos, non-combustible blankets composed of compounds of spun mineral fiber felt, complying with ASTM C665, Type I.
      a. Physical Properties:
         1) Thermal Conductivity (k), ASTM C518: 0.25 Btu/inch/hour/square foot/degree F.
         2) Density, Manufacturer's Certified Test: Four pounds per cubic foot (pcf).
         3) Flame Spread, ASTM E84: 15 maximum.
         4) Smoke Developed, ASTM E84: Five maximum.
         5) Fire Resistance Rating, ASTM E119: two-hours.

b. Thickness: as indicated on drawings.
c. Width: as indicated on drawings.
d. Products and Manufacturers: Provide one of the following:
    1) Thermafiber Safing Insulation by USG Interiors, Inc.
    2) FBX Safing Insulation by Fibrex, Inc.
    3) Or equal.

C. Fire-Stop Sealants and Other Fire-Stop System Components: Provide the following:
1. Complete selection of fire-stop manufacturer's recommended silicone rubber fire-stop systems. Provide complete systems complying with UL 1479 with two- or three-hour fire rating. Provide equal fire protection as provided by fire-rating of construction penetrated.
2. Provide multiple component systems coordinated to meet actual conditions encountered in the Work and as recommended by fire-stop manufacturer. In addition to providing fire resistance, fire-stop systems shall also be gas and watertight.
3. Products and Manufacturers: Provide one of the following:
    a. 3M Fire Stop Systems by 3M, Inc.
    b. Fire Stop Systems by USG Interiors, Inc.
    c. Or equal.

D. Miscellaneous Materials and Accessories: Provide the following:
1. Adhesive for Bonding Insulation: Type recommended by insulation manufacturer, and complying with fire resistance requirements.
2. Safing Impaling Clips: Provide galvanized steel impaling clips complying with requirements of code authorities having jurisdiction at the Site and as recommended by insulation manufacturer for full system responsibility.
3. Protection Board: Fiberboard sheathing or heavy duty asphaltic panels as recommended by insulation manufacturer.
4. Adhesive Tapes: Complete selection of insulation manufacturer's recommended taping materials.
5. Bitumen: Asphalt, ASTM D 449.

PART 3 – EXECUTION

3.01 INSPECTION

A. Contractor and installer shall examine substrate and conditions under which building insulation Work will be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surfaces to receive building insulation shall be clean of all debris, dirt, and other contamination before installation begins.

3.03 INSTALLATION

A. General:
   1. Comply with manufacturer's instructions for particular conditions of installation in each case. If printed instructions are not available or do not apply to Site conditions, before proceeding with the Work obtain from manufacturer and submit to Engineer specific installation recommendations from manufacturer.
   2. Extend insulations full thickness over entire surface to be insulated. Cut and fit tightly around obstructions. Fill voids with insulation.
   3. Apply number of layers of insulation specified, each of required thickness, or required thickness to provide thermal value shown or indicated in the Contract Documents, to make up the total thickness.

B. Unit-type Building Insulation:
   1. Apply insulation units of type shown or indicated to substrate by method indicated. If not otherwise indicated and except for units resting on horizontal surfaces, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

C. Safing Insulations and Fire-Stop Systems:
   1. Install safing insulation and fire-stop systems to present continuous fire-rated fire barrier in areas shown and at perimeter of all fire-rated partitions and poke-through floor and wall penetrations, to maintain continuity of fire-rated construction whether or not shown.
   2. Install fire stop sealants and other fire stop system components in thicknesses recommended by manufacturer at all locations where poke-through penetrations occur, at all locations where other penetrations such as ducts, pipe, cables, cable trays, and conduit occur and at perimeter of all fire-rated walls.
   3. Include all components of manufacturer's fire/smoke-stop systems for complete system responsibility installed in accordance with manufacturer's written recommendations and specifications.

D. Board-type Perimeter Insulation:
   1. Install perimeter insulation after concrete footings have been poured and before on-grade concrete slab work begins.
   2. Remove projections that interfere with placing.
   3. Apply single 2.0-foot-wide continuous band of insulation of required thickness and number of layers at slab-on-grade buildings whether or not shown. Stagger joints between layers of insulation and butt insulation tightly together.
   4. Apply single 2.0 foot-wide continuous field of insulation of required thickness and number of layers to foundation walls on below grade rooms whether or not shown. Stagger joints between layers of insulation and butt insulation tightly together.
   5. Protect top surface of horizontal insulation from damage during concrete Work by applying protection course material recommended by insulation manufacturer.

6. On vertical surfaces, set units in adhesive applied in accordance with manufacturer's instructions. Use type of adhesive recommended by manufacturer of board-type perimeter insulation.
7. Tape bottom edge of insulation before temporarily attaching insulation to wall with mastic.
8. Tape all joints in vertical wall insulation.
9. Protect insulation on vertical surfaces from damage during backfilling by applying protection course material recommended by insulation manufacturer. Set in adhesive in accordance with recommendations of insulation manufacturers and protection course material.

E. Cavity Wall Rigid Insulation Board:
1. Install exterior wall rigid insulation board after all concrete unit masonry Work is complete.
2. Apply single layer of insulation cut to fit snugly and uniformly and in continuous contact with edges of continuous masonry horizontal joint reinforcement over entire plane of the wall.
3. Apply exterior wall rigid insulation to exterior concrete unit masonry walls in areas shown or indicated as receiving masonry outer cavity wall wythes.
4. Set units in adhesive applied in accordance with manufacturer's instructions. Use type of adhesive recommended by manufacturer of board-type cavity wall insulation.

F. Correcting Defective Work:
1. System components that are dislodged, damaged, expanded, broken, penetrated, or crushed by subsequent installation operations or damaged by detrimental weather shall be immediately replaced with undamaged material in compliance with the Contract Documents and properly protected as specified.
2. Only original installer shall repair or replace deteriorated or defective Work.

3.04 PROTECTION

A. Protection from Elements:
1. Protect all components of the Work from detrimental weather conditions. Do not allow building insulation materials to become wet or soiled, or covered with ice or snow. Provide continuous protection of materials against damage, wetting and moisture absorption and storing materials as specified
2. Work that cannot, for reasons acceptable to Engineer, be covered with complete construction system before onset of weather detrimental to the Work, shall be completely covered and protected in manner that deflects precipitation from building insulations without damaging adjacent Work.
3. Protect foam plastic building insulation from exposure to sunlight.

B. Protection During Construction:

1. Protect all components of the Work from construction operations including, but not limited to, backfilling, framing, and sheathing, aluminum siding, and concrete unit masonry Work, until work is completed and acceptable to Engineer.
2. Protect building insulations from damage and abuse by other contractors and installers until readiness for final payment.
3. Do not allow building insulations to come into contact with welding operations or other fire or ignition sources.
4. Do not allow construction traffic not associated with installation of building insulation in the area of building insulation Work. Protect the area from access by other installers and contractors until the building insulation Work has been incorporated into finished construction systems.

C. Building insulation that becomes wet, damaged, or deteriorated shall be promptly removed from the Site and replaced with materials conforming to this Section.

+ + END OF SECTION + +

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SECTION 07212

SPRAYED FIBER INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cellulose insulation applied to underside of structure

B. Work to be coordinated with Section 07210 – Building Insulation.

1.02 REFERENCE STANDARDS

A. ASTM C1149 - Standard Specification for Self-Supported Spray Applied Cellulosic Thermal Insulation; 2017.

B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.

C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

D. ASTM C739 - Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation; 2021a.

E. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics; 2020.

F. ASTM D1622/D1622M - Standard Test Method for Apparent Density of Rigid Cellular Plastics; 2020.

G. ASTM E736/E736M - Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members; 2019 (Reapproved 2023).

H. ASTM E759/E759M - Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members; 1992 (Reapproved 2023).

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

J. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C; 2019a.

K. ISO 9001 - Quality Management Systems — Requirements; 2015.

1.03 SUBMITTALS

A. See Section 01300 - SUBMITTALS for submittal procedures.

B. Product Data: Provide data on materials, describing insulation properties and sealer.

C. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.
   1. Manufacturer's written certification that product contains no asbestos, fiberglass or other man- made mineral fibers.
   2. Copy of manufacturer's ISO 9001, latest edition, Certification.
   3. Minimum Fiber Recycled Content to be 75%.
   4. Certification that material does not contain any Urea-Formaldehyde Resins.

D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.

E. Manufacturer shall provide a current Underwriters Laboratories (UL) Code Evaluation Report.

F. Provide certification that the materials being submitted are in compliance with the latest edition of the International Building Code applicable in the jurisdiction of the project.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.

B. Installer Qualifications: Company licensed by the Spray Insulation manufacturer specializing in performing the work of this section with minimum five years of experience.

C. Products Specified by Flammability or Combustibility Criteria: Listed and classified by Underwriters Laboratories Inc.

D. Manufacturer must subscribe to independent laboratory follow-up inspection services of Underwriters Laboratories and Factory Mutual. Each bag shall be labeled accordingly.

E. Material shall have been tested and certified under ASTM E1042 by a NVLAP accredited laboratory. Provide certifications.

1.05 MOCK-UP

A. Provide installation mock-up, six feet (1.83 m) long by three feet (.91 m) wide or at least one structural bay width, illustrating ceiling construction.

B. Locate where directed by the Architect.

C. Mock-up may remain as part of the Work.

1.06 FIELD CONDITIONS

A. Do not install insulation, when ambient and surface temperatures are lower than 50 degrees F (10 degrees C).

B. Maintain acceptable ambient and substrate surface temperatures prior to, during, and after installation of insulation materials and sealer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cellulose Fiber:
   1. International Cellulose Corp; K-13 Spray-On Systems: 12315 robin Boulevard, Houston, Texas 77045, T: 800.444.1252; F: 713.433.2029; E: icc@spray-on.com ; www.spray-on.com.
   2. Architect approved equivalent.

2.02 MATERIALS

A. Cellulose Fiber Insulation:
   1. K (ksi) factor: 0.22 K (0.38 ksi), when tested in accordance with ASTM C177.
   2. R-Value: 3.75 per inch thickness, ASTM C518.
   3. Density: 2 lb/cu ft (32 kg/cu m), when tested in accordance with ASTM D1622.
   4. NRC: 0.75 for 1 inch (25 mm) thickness.
   5. Moisture Absorption: Maximum 15 percent by weight.
   6. Flame Spread and Smoke Developed Index: Class 1, Class A when tested in accordance with ASTM E84.
   7. Combustibility: Passing ASTM E136.
   8. Bond Deflection: 6" deflection in 10 foot span - No spalling or Delamination in accordance with ASTM E759/E759M.
   9. Material shall conform to ASTM C1149.
   10. Provide material thickness as shown on the drawings but no less than 1 inch thickness.
   11. Color: White

2.03 ACCESSORIES

A. Primer: As required by insulation manufacturer.

B. Insulation Surface Sealer: Clear, latex base.

C. Insulation Stop: Plastic, profiled and sized to suit rafter spacing and wall/sloped roof configuration.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are clean, dry, and free of matter that may inhibit adhesion. Provide priming/sealing to insure bonding and/or to prevent discoloration caused by migratory stains.

B. Examine surfaces and report unsatisfactory conditions in writing. Do not proceed until unsatisfactory conditions are corrected.

C. Verify that ceiling hangers and supporting clips have been are installed correctly.

D. Verify other work on and within spaces to be insulated is complete prior to application.

3.02 PREPARATION

A. Mask and protect adjacent surfaces from overspray or damage.

B. Apply primer in accordance with manufacturer's instructions.

C. For installation over spray applied fire resistive materials (SAFM) allow SAFM to fully cure prior to installation of sprayed fiber insulation and follow all other requirements of SAFM manufacturer.

3.03 INSTALLATION

A. Install insulation in accordance with manufacturer's instructions.

B. Install insulation to a uniform monolithic density without voids.

C. Install to achieve a cured thickness of at lest three inches with an R-value of 11.25.

D. Tamp wet insulation surface to improve adhesion and to achieve a smooth surface. Cure insulation with continuous natural or mechanical ventilation.

E. Remove and dispose of over-spray.

3.04 FIELD QUALITY CONTROL

A. Independent agency field inspection will be provided under provisions of Section 014000 - Quality Requirements.

B. Inspection will include verification of insulation and sealer thickness and density.

3.05 PROTECTION

A. Do not permit subsequent construction work to disturb applied insulation.

+ + END OF SECTION + +

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SECTION 07272

FLUID-APPLIED MEMBRANE AIR AND WATER BARRIERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes vapor-permeable, fluid-applied air and water barriers applied to exterior Concrete Unit Masonry backup walls.

1.03 DEFINITIONS

A. Weather Barrier: A combination of materials and accessories that do the following:
   1. Prevent the accumulation of water as a water-resistive barrier.
   2. Minimize the air leakage into or out of the building envelope as a continuous air barrier.
   3. Provide sufficient water vapor transmission to enable drying as a vapor permeable membrane.

B. Water-Resistive Barrier: A combination of materials and accessories that prevent the accumulation of water within the wall assembly in accordance with IBC Section 1403.2.
   1. Primary Layer: Water-resistive barrier (fluid-applied) installed closest to building interior with all flashings and terminations integrated to this layer.
   2. Secondary Layer: Outermost part of a double-layer system and where drainage is required behind claddings such as stucco, adhered masonry, and installation methods utilizing a lath.

C. Continuous Air Barrier: The combination of interconnected materials, assemblies, and sealed joints and components of the building envelope that minimize air leakage into or out of building envelope in accordance with ASHRAE 90.1 Section 5.4.3.1.

D. Vapor-Permeable Membrane: The property of having a water-vapor permeance rating of 10 perms or greater, when tested in accordance with the desiccant method using Procedure A of ASTM E96 in accordance with definition in International Building Code. Vapor-permeable material permits passage of moisture vapor through vapor diffusion.

E. Vapor Diffusion: A slow movement of individual water vapor molecules from regions of higher to lower water vapor concentration (higher to lower vapor pressure).

1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, Manufacturer's Certified Installer, weather barrier manufacturer's designated field representative, and installers of work that interfaces with or affects weather barrier.
   2. Review methods and procedures related to weather barrier installation, including manufacturer's written instructions.
   3. Review and finalize construction, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Examine substrate conditions and finishes for compliance with requirements.
   5. Review flashings, special weather barrier details, weather barrier penetrations, and condition of other construction that affects weather barrier.
   6. Review weather barrier manufacturer's Project registration and observation process.
   7. Review Construction Indoor Air Quality Management Plan "Moisture Protection for Absorbent Materials."
   8. Review temporary protection requirements for weather barrier during and after installation.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. For weather barrier, include data on air and water-vapor permeance based on testing in accordance with referenced standards.

B. Manufacturer's Instructions: For installation of each product specified.

C. Qualification Data: For Installer, laboratory mockup testing agency and field testing agency..

D. Sample Warranty: For manufacturer's warranty.

E. Installer Qualifications: A qualified firm that is certified by weather barrier system manufacturer to install manufacturer’s product.

F. Mockups: Build mockups to set quality standards for materials and execution.
   1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
      a. ASTM E 331 Test Parameters: 2.86 psf (137 Pa) pressure for 15-minute duration.
      b. AAMA 501.1 Test Parameters: 2.86 psf (137 Pa) pressure for 15-minute duration.
      c. AAMA 501.5 Test Parameters:
         1) Cycle Temperature Range: 0 to 180 deg F (-18 to +82 deg C).
         2) Number of Cycles: 3.

3) Repeat test ASTM E 331 after thermal cycling.

2. Warranty Period: 15 years from date of product purchase.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Obtain weather barrier assembly components, including weather barrier, weather barrier flashing and foam insulation from same manufacturer as weather barrier or manufacturer approved by weather barrier manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. High-Performance Installations:
   1. For installation with one of the following building envelope performance or structural characteristics:
      a. Exceeding 65 mph (100 km/h) equivalent structural load.
      b. Exceeding 15 mph (24 km/h) equivalent wind-driven rain water infiltration.
      c. Buildings with 60 feet (18 m) or more total height above grade plane, as defined by the IBC.
      d. Construction with gypsum or cement-based exterior sheathing.
      e. Non-wood based primary structure such as steel, light-gauge steel, masonry, or concrete.

2.03 WEATHER BARRIER

A. Water Penetration Resistance, Product: Hydrostatic-head resistance greater than 92.5 inches (235 cm) in accordance with ASTM E331.

B. Weather barrier system shall have a VOC content of 30 g/L or less.

2.04 WEATHER BARRIER FLASHING

A. Conformable Weather Barrier Flashing: Composite flashing material composed of micro-creped, polyethylene laminate with a 100 percent butyl-based adhesive layer; AAMA 711 Class A (no primer), Level 3 thermal exposure of 176 deg F (80 deg C) for seven days.
   1. Basis-of-Design Product: DuPont Safety & Construction: E. I. du Pont de Nemours and Company; FlexWrap™ NF.
      a. Or approved equal.
   2. Conformability: Able to create a seamless sill pan extending up the jambs without cuts, patches, or fasteners.

B. Strip Flashing: Composite flashing material composed of spunbonded polyethylene laminate with a 100 percent butyl-based adhesive layer; AAMA 711, Class A (no primer), Level 3 thermal exposure of 176 deg F (80 deg C) for seven days.

1. Basis-of-Design Product: DuPont Safety & Construction: E. I. du Pont de Nemours and Company; Tyvek® StraightFlash™, Tyvek® StraightFlash™ VF.
    a. Or approved equal.

2.05 DRAINAGE LAYER

A. Drainage Layer: Weather barrier membrane with drainage.
    1. Basis-of-Design Product: DuPont Safety & Construction: E. I. du Pont de Nemours and Company; Tyvek® Fluid Applied WB+™ and CommercialWrap® D.
        a. Or approved equal.
    2. Drainability: 98 percent or greater when tested in accordance with ASTM E 2273.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
    1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
    2. Verify that substrates have cured and aged for minimum time recommended in writing by weather barrier manufacturer.
    3. Verify that substrates are visibly dry and frost-free.
        a. Fluid-applied weather barrier may be applied to damp surfaces.
        b. Surfaces are considered damp if there is no visible water on the surface, and no transfer of water to the skin when touched.
        c. Apply accessory products only to clean and dry surfaces.
    4. Verify that substrates are free of efflorescence and mold.
    5. Verify that masonry joints are flush and filled with mortar.
    6. Verify that top-of-wall system has been capped or covered to prevent water getting behind the facade and into wall cavity.
    7. Verify continuous path for moisture drainage.
        a. Verify that continuous path for drainage is not blocked or disrupted, which results in excess moisture buildup in wall cavity.
    8. Verify that surfaces to receive weather barrier are above grade.

B. Verify that substrate and surface conditions are in accordance with commercial weather barrier manufacturer recommendations prior to installation.
    1. Verify that rough sill framing for doors and windows slopes downward towards the exterior and is level across width of opening.

C. Verify air and surface temperatures are above 25 deg F (4 deg C) with a maximum surface temperature of 140 deg F (60 deg C). Do not install once ambient temperature exceeds 95 deg F (35 deg C), unless surface is shaded.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate in accordance with manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.

B. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

C. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.

D. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

E. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

F. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

G. When spraying is method of application, taper ends of the joint treatment to assist maintaining a wall system free of pinholes and voids

H. Treat all non-moving transition joints to beams, columns, and dissimilar materials by applying a 2 inch (50-mm) wide by 60-mil (1.5-mm-) thick coat of fluid-applied flashing across the joint.

I. Apply 25-mil- (0.6-mm-) thick coat of fluid-applied flashing, extending a minimum 2 inches (51 mm) on each surface, and treat the following conditions:
   1. Joints up to 1/4 inch (6 mm).
   2. Joints 1/4- to 1/2-inch (6- to 13-mm); reinforce with fiberglass-mesh tape.
   3. Joints and transitions up to 1 inch (25 mm); treat using strip flashing.

J. Bridge [isolation joints] [expansion joints] [and] discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement in accordance with manufacturer's written instructions and details.

K. When spraying is method of application, taper ends of fluid applied corner treatment to wall substrate.

L. Treat inside and outside corners by applying a 25-mil- (0.6-mm-) thick coat of fluid applied weather barrier a minimum 2 inches (50 mm) on each adjoining surface. Apply fillet bead of fluid-applied sealant to inside corners to ensure continuity. Alternatively,

treat corners using strip flashing. Press strip flashing into inside corners; ensure that it is fully adhered to substrate.

M. Seal penetrations using fluid-applied flashing or sealant. Extend fillet bead 1/2 inch (13 mm) onto both surfaces.

N. Treat embedded masonry anchors by applying a coat of fluid-applied weather barrier or fluid-applied flashing around base of the anchor.

3.03 ACCESSORIES INSTALLATION

A. Install accessory materials in accordance with air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.
   1. Coordinate installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
   2. Install transition strip on roofing membrane or base flashing, for a minimum 3 inches (75 mm) coverage over each substrate.
   3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow to dry.
   4. Use recommended primer when applying self-adhered flashing products on concrete, masonry, and fiber faced exterior gypsum board substrates. Priming is generally not required for adhering self-adhered flashing products to wood. However, adverse weather conditions or colder temperatures may require a primer to promote adhesion. Priming is not required when applying fluid-applied products, except on cut edges of exterior gypsum sheathing.
   5. Apply pressure along entire surface of strip flashing for good bond using a J-roller or firm hand pressure. Remove all wrinkles and bubbles by smoothing surface and repositioning as necessary.

B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

C. When applying self-adhered flashing products over a cured fluid-applied membrane, first apply a wet bed of fluid-applied product.

D. Seal fasteners of mechanically attached supports or furring strips in high-performance building envelope designs.
   1. Apply double-sided butyl tape to back of support bracket at fastener location.
   2. Embed support bracket into an additional wet bed of fluid applied product.
   3. Adhere butyl-based flashing patch to wall at fastener location.
   4. Use alternate method as approved by the manufacturer.

E. At end of each working day, seal top edge of strips and transition strips to substrate with manufacturer approved product.

F. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Flashing Sill Area for Windows and Doors:
   1. Use 6-inch (150-mm-) wide conformable flashing for 2 by 4-inch (50- by 100-mm) framing and 9-inch (220-mm-) wide conformable flashing for 2 by 6-inch (50- by 150-mm) framing. When rigid back dams are required or desired, one option to use is a 3/4-inch (19 mm) corner guard (back dam), cut to length of sill, and nailed into place on interior edge of sill prior to installation of 9-inch (220-mm-) wide conformable flashing. Afterward, install 9-inch (220-mm-) wide conformable flashing over sill and corner guard back dam.
   2. Install without stretching conformable flashing when installing along sills or jambs. Conformable flashing is intended to be stretched when covering corners or curved sections.

H. Apply fluid-applied flashing products from head of opening down. Use a corner trowel to smooth corners.

I. Repairs:
   1. Coat small damaged areas with layer of fluid-applied product.
   2. Reinforce large damaged areas with fiberglass mesh or replace damaged substrate before reapplying fluid-applied product.

3.04 PRIMARY AIR-BARRIER MATERIAL INSTALLATION

A. Apply air-barrier material to form a seal with strips and transition strips, and to achieve a continuous air barrier in accordance with air-barrier manufacturer's written instructions and details. Apply air-barrier material within manufacturer's recommended application temperature ranges.
   1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
   2. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
   3. Where multiple prime coats are needed to achieve required bond, allow adequate drying time between coats.
   4. Fluid applied products may be overcoated once a touch-free skin has formed. Exterior insulation and cladding may be installed once the membrane has cured sufficiently to resist damage during installation.

B. Apply air barrier material in accordance with air-barrier manufacturer's written instructions and recommendations.
   1. Roller Application:

a. Nap rolling: Use a roller cover with a 1/2- to 3/4-inch (13- to 19-mm) nap.

2. Spray Application:
   a. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
   b. Use spray guard.
   c. Back Rolling: Use a roller cover with a 1-1/2- to 3/4-inch (13- to 19-mm) nap. Apply fluid-applied product in a single coat at 25 mils (0.64 mm) thick. Control thickness by applying appropriate volume over a marked area and spot checking with a wet-mil gauge.

C. Integrate fluid-applied product with through-wall flashing and window and door flashing by overlapping flashing with fluid-applied product a minimum 2 inches (50 mm).

D. Inspect surfaces to ensure that fluid-applied products are continuous and free of any voids or pinholes.

E. Do not cover air barrier until it has been tested and inspected by the testing agency.

F. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.05 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing Agency: Engage a qualified third-party testing agency to perform tests and inspections.

C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
   1. Continuity of air-barrier system has been achieved throughout the building envelope without gaps, holes, or pinholes.
   2. Air-barrier dry film thickness.
   3. Continuous structural support of air-barrier system provided.
   4. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
   5. Site conditions for application temperature, and dryness of substrates are maintained.
   6. Maximum exposure time of materials to UV deterioration not exceeded.
   7. Surfaces primed, where applicable.
   8. Laps in strips and transition strips comply with minimum requirements, are shingled in correct direction (or mastic applied on exposed edges), and are without fishmouths.
   9. Termination mastic applied on cut edges.

10. Strips and transition strips firmly adhered to substrate.
11. Compatible materials used.
12. Transitions at changes in direction and structural support at gaps provided.
13. Connections between assemblies (air-barrier and sealants) comply with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
14. Each penetration sealed.

D. Field Quality Control Testing: Perform the following test on mockups and representative areas of structural sealant glazed curtain walls.
   1. Air Infiltration Whole Building: ASTM E2357 at not more than 0.25 cfm/sf (1.25 L/s per sq. m) at 1.57 lb/sq. ft. (75 Pa).
   2. Water Penetration: 1 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article in Part 2, but not less than 6.24 lbf/sq. ft. (300 Pa). No water penetration shall occur as defined in ASTM E331.
      a. Perform a minimum of two tests in areas as directed by Architect.
   3. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate in accordance with ASTM D 4541 for each 600 sq. ft. (56 sq. m) of installed air barrier or part thereof.

E. Air barriers will be considered defective if they do not pass tests and inspections.
   1. Apply additional air-barrier material, in accordance with manufacturer's written instructions, where inspection results indicate insufficient thickness.
   2. Remove and replace deficient air-barrier components for retesting as specified above.

F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

G. Prepare test and inspection reports.

3.06 CLEANING AND PROTECTION

A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.
   1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials in accordance with air-barrier manufacturer's written instructions.
   2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

C. Remove masking materials after installation.

+ + END OF SECTION + +

SECTION 07411

STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes:
   1. Standing-Seam Metal Roof Panels.
   2. Underlayment Materials.
   3. Miscellaneous Materials including:
      a. Panel Accessories
      b. Flashing & Trim
      c. Fasteners
      d. Sealants

1.03 SYSTEM PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.
   3. Deflection Limits: For wind loads, no greater than 1/240 of the span.

B. Air Infiltration: Air leakage of not more than 0.04 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E1680 at the following test-pressure difference:
   1. Test-Pressure Difference: 4 lbf/sq. ft.

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 at the following test-pressure difference:
   1. Test-Pressure Difference: No uncontrolled water penetration at a static pressure of 6.4 lb. /sq. ft.

D. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
   1. Uplift Rating: UL 90.
   2. Uplift Load: ASTM E1592.

E. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are

listed in FM Global' s "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
1. Fire/Windstorm Classification: Class 1A-90.
2. Hail Resistance: SH (Severe Hail).

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:
1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).

C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.05 INFORMATIONAL SUBMITTALS

A. Manufacturer Qualification Statement: Provide documentation showing metal roof panel fabricator is accredited under IAS AC472.

B. Qualification Data: For Installer.

C. Product Test Reports: For each product, for tests performed by a qualified testing agency.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in the manufacture of roofing systems similar to those required for this project.
   1. Not less than 5 years of documented experience.
   2. Accredited by IAS according to IAS AC472.

B. Test Reports: Indicate compliance of metal roofing system to specified requirements.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.08 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, and Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
   2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
   4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
   5. Review structural loading limitations of deck during and after roofing.
   6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
   7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
   8. Review temporary protection requirements for metal panel systems during and after installation.
   9. Review procedures for repair of metal panels damaged after installation.
   10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, underlayments and other manufactured items so as not to be damaged or deformed. Package metal panels, accessories, trims and

underlayments for protection during transportation and handling. Follow all delivery, storage and handling requirements of the manufacturer.

B. Unload, store, and erect metal panels, accessories and trims in a manner to prevent bending, warping, twisting, and surface damage.

C. Store roll materials on end on a clean, flat and dry location raised above grade and out of direct sun and exposure to the elements until time of application.

D. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

E. Retain strippable protective covering on metal panels during installation.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.11 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including rupturing, cracking, or puncturing.
      b. Deterioration of metals and other materials beyond normal weathering.
   2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D2244.

b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion (including Coastal locations within 1500 feet of the Coastline).

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
1. Warranty Period: Twenty (20) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels : Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. CENTRIA Architectural Systems: SRS 3 Structural Standing Seam Metal Roof Panel System, (Basis-of-Design)
b. ATAS International, Inc.; Field-Lok
c. Englert, Inc
d. Architect approved equivalent.
2. Stainless-Steel Face Sheet: ASTM A 666, architectural grade alloy type as indicated:
a. Face Sheet: 0.030 inch/22 gage (0.76 mm) nominal thickness.
b. Finish: Type 316, #4 Brushed.
c. Color:
1) Exterior Surface: Brushed to match wall panels.
2) Interior Surface: Manufacturer's standard primer color.
3. Structural Standing Seam Metal Roof Panels: Formed with 3 inch (76 mm) high vertical ribs at panel edges[and evenly spaced raised longitudinal planks], manufactured for sequential installation by attaching panels to supports using concealed clips and engaging edges of adjacent panels and mechanically seaming panel ribs together, sealed with factory-applied sealant.
a. Panel Coverage: 12 inch (406 mm).
b. Anchor Clips:
1) Stainless steel, 2-piece, 16 ga., movement allowance 3 inch (76 mm).
c. Joint Type: As standard with manufacturer.

d. Panel Seam Height: 3 inch.

2.02 METAL ROOF PANEL ACCESSORIES

A. General: Provide complete metal roof panel assembly incorporating trim, copings, fascia, soffits, downspouts, insulation spacers and miscellaneous flashings. Provide required fasteners, gaskets, closure strips, and sealants. Fabricate and install accessories in accordance with SMACNA Manual.
   1. Steel Roof Panel Systems: Comply with ASTM E 1514.
   2. Flashing and Trim: Match material, thickness, and finish of metal roof panels.

B. Perforated Soffit System: Provide complete 304 stainless steel panel system supplemental support using 16-gauge furring channels 16-inches on center. Structural design based on performance requirements as indicated in Part 1 of this specification.
   1. Perforated Panels, General: Factory-formed, exposed fastener panels with interconnecting side joints, fastened to supports with exposed fasteners, fastened to supports with exposed fasteners.
   2. Panel Profile: Symmetrical corrugated profile with lap joint
      a. Basis of Design Product: CENTRIA, Econolap 3/4 inch
      b. Panel Coverage: 34.66 inches.
      c. Panel Height: 0.75 inches
      d. Corrugation Spacing: 2.66 inches (68 mm) o.c.
   3. Flashing, Trim: Match material, thickness, and color of metal panel face sheets.
   4. Fasteners: Self-tapping 300 series stainless steel screws, No. 14 minimum, hex-head, and other acceptable fasteners recommended by panel manufacturer.

C. Panel Fasteners: Self-tapping screws, bolts, nuts, and other acceptable fasteners recommended by roof panel manufacturer. Where exposed fasteners cannot be avoided, supply corrosion-resistant fasteners with heads matching color of metal panels by means of factory-applied coating.
   1. Exposed Screws: Manufacturer's recommended stainless steel screws with bonded neoprene and stainless steel washers, coated to match panel color.
   2. Concealed Screws: Manufacturer's recommended corrosion resistant carbon steel with corrosion resistant coating.

D. Panel Sealants:
   1. Side Lap Sealant: One part, non-skinning, non-drying, synthetic butyl elastomer sealant.
   2. Field Applied Unexposed Sealant: Side Laps, end laps, and flashing details: Gun grade, nonskinning, butyl elastomer or polymeric non-skinning butyl tape.
   3. Exposed Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; as recommended by metal roof panel manufacturer colored to match panel color.

2.03 UNDERLAYMENT MATERIALS

A. Provide underlayment materials as required by the roofing manufacturer.

B. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils (0.76 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
   1. Underlayment shall be approved by the metal roofing panel manufacturer.
   2. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D1970/D1970M.
   3. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D1970/D1970M.
   4. Products: Subject to compliance with requirements, provide the following:
      a. Carlisle Residential, a division of Carlisle Construction Materials; WIP 300HT.
      b. Grace Construction Products, a unit of W. R. Grace & Co.; Grace Ice and Water Shield HT.
      c. Henry Company; Blueskin PE200 HT.

C. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felts.

D. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.04 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Sub framing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including but not limited to: eave trim, z closures, edge and starter cleats, joggle cleats, pop rivets, sealants, gaskets, filler strips, and closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
   1. Closure Strips: Closed-cell, expanded, cellular, rubber or cross-linked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-(25-mm-) thick, flexible closure strips; cut or Premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations

include, but are not limited to, eave trim, shed ridge trim, sidewall trim, step flashing, base flashing, counterflashing, valley flashing , z closures, fascias, and crickets. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
   1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
   2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
   3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.05 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   3. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
   4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

2.06 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
   1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
   2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
      a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.03 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation.

Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the roof area indicated below:
    a. Roof perimeter for a distance up from eaves of 36 inches beyond interior wall line.
    b. Valleys, from lowest point to highest point, for a distance on each side of 18 inches. Overlap ends of sheets not less than 6 inches.
    c. Rake edges for a distance of 18 inches.
    d. Hips and ridges for a distance on each side of 12 inches.
    e. Roof-to-wall intersections for a distance from wall of 18 inches.
    f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches.

B. Underlayment: Apply at locations indicated below, in shingle fashion to shed water, and with lapped joints of not less than 3 inches.
    1. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than 4 inches, in shingle fashion to shed water.

C. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.

D. Flashings: Install flashings to cover underlayment to comply with manufacturer's requirements.

3.04 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
    1. Shim or otherwise plumb substrates receiving metal panels.
    2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
    3. Install screw fasteners in predrilled holes.
    4. Locate and space fastenings in uniform vertical and horizontal alignment.
    5. Install flashing and trim as metal panel work proceeds.
    6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
    7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
    8. Provide weathertight escutcheons for pipe and conduit-penetrating panels.

B. Fasteners:
   1. Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior. Exposed pop-rivets shall be finished to match panel materials.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
   1. Install clips to supports with self-tapping fasteners.
   2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
   3. Watertight Installation:
      a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
      b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
      c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of inter meshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.05 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.07 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

+ + END OF SECTION + +

SECTION 07461

PREFORMED METAL SIDING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install preformed metal siding which includes a complete system with the following integrated components.
      a. Integrated window system.
      b. Integrated louvers
      c. Concealed Fastener Metal Panel
      d. Ceiling / Soffit Panels.
      e. Secondary metal framing, including integrated through-tube supports.
   2. Coordination:
      a. Review installation procedures under other Sections and coordinate installation of items that must be installed with preformed metal siding Work.
      b. Coordinate installation of preformed metal siding and associated Work to provide complete system complying with combined recommendations of manufacturers and installers involved in the Work.
      c. Cooperate with inspection and test agencies engaged by Owner, and authorized by metal wall panel manufacturer, in connection with the preformed metal siding and associated Work.
   3. Related Sections:
      a. Section 03300 – Cast-In-Place Concrete
      b. Section 05050 - Metal Fastening
      c. Section 05120 - Structural Steel
      d. Section 06100 - Rough Carpentry
      e. Section 07263 - Spray Polyurethane Foam Insulation
      f. Section 07620 - Sheet Metal Flashing and Trim
      g. Section 07710 - Roof Specialties.
      h. Section 07920 - Joint Sealants
      i. Section 08131 - Stainless Steel Doors and Frames
      j. Section 08311 - Access Doors and Frames
      k. Section 08800 – Glass and Glazing
      l. Section 10200 - HVAC Louvers
      m. Section 13101 - Lightning Protection Systems

1.02 REFERENCES

A. Standards referred in the section or referred in Product Performance Standards are listed below:
   1. NYSBC New York State Building Codes
   2. AAMA 501.1 - Standard Test Method for Exterior Windows, Curtain Walls and Doors for Water Penetration Using Dynamic Pressure.
   3. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems.
   4. AAMA 508-07 - Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems.
   5. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
   6. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance.
   7. ASTM A 653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   8. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   9. ASTM A 755 - Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
   10. ASTM B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
   11. ASTM B 209 - Specification for Aluminum and Aluminum Alloy Sheet and Plate.
   12. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   13. ASTM C 209 - Standard Test Methods for Cellulosic Fiber Insulating Board.
   14. ASTM C 645 - Specification for Nonstructural Steel Framing Members.
   15. ASTM C 754 - Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum Panel Products.
   16. ASTM C 920 - Specification for Elastomeric Joint Sealants.
   17. ASTM C 1363 - Standard Test Method for thermal performance of building materials and envelope assemblies by means of a Hot Box Apparatus.
   18. ASTM D 968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
   19. ASTM D 3359 - Standard Test Methods for Measuring Adhesion by Tape Tests.
   20. ASTM D 4585 - Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation.
   21. ASTM D 4587 - Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
   22. ASTM E 72 - Conducting Strength Tests of Panels for Building Construction, Methods of
   23. ASTM E84 - Surface Burning Characteristics of Building Materials, Test Method for
   24. ASTM E 96 - Test Methods for Water Vapor Transmission of Materials.
   25. ASTM E 119 - Fire Tests and Building Construction and Materials

26. ASTM E 283 - Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen, Test Method for
27. ASTM E 330 - Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference, Test Methods for
28. ASTM E 331 - Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference, Test Method for
29. ASTM E 1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.
30. ASTM E 1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
31. ASCE 7 Minimum Design Loads for Buildings and Other Structures.
32. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.
33. ANSI/FMG 4880 - Standard for Evaluating Insulated Wall & Roof/Ceiling Assemblies.
34. SMACNA Sheet Metal and Air Conditioning Contractors National Association, Inc.: Architectural Sheet Metal Manual.
35. UL 263 - Fire Tests of Building Construction and Materials.
36. UL 723 - Test for Surface Burning Characteristics of Building Materials.
37. AMCA 500 - Laboratory Methods of Testing Louvers for Rating
38. AAMA 2605 - Superior Performing Organic Coatings on Aluminum Extrusions and Panels

1.03 QUALITY ASSURANCE

A. Manufacturer/Source: Provide metal wall panel system, complete with secondary metal framing, structural tube supports, window units, and louvers, and panel accessories from a single manufacturer as well as the following integrated components:
   1. Integrated window system.
   2. Integrated Louvers, including integrated through tube supports
   3. Concealed Fastener Metal Panel
   4. Conductor Head and Leaders (as specified elsewhere).
   5. Secondary metal framing, including integrated through-tube supports.

B. Engage a single skilled fabricator, trained and with 10 years of successful experience in the fabrication of preformed metal siding and with specific skill and successful experience in the fabrication of the types of materials required; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualification to Engineer along with the following information on a minimum of three successful projects:

1. Names and telephone numbers of owner, architects or engineers responsible for projects.
2. Approximate contract cost of the preformed metal siding.
3. Amount of area installed.

C. Manufacturer Qualifications: Approved manufacturer listed in this Section with minimum 10 years experience in manufacture of similar products in successful use in similar applications.
   1. Approval of equal Products and integrated systems: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:
      a. Product data, including certified independent test data indicating compliance with requirements. Include detailed data indicating compliance with AAMA 508.07 performance specified in this section.
      b. Sample submittal from similar project.
      c. Project references: Minimum of 5 installations not less than 5 years old, with Owner and Architect contact information.
      d. Sample warranty.

D. Testing Agency Qualifications: Qualify in accordance with requirements of ASTM E329.

E. Adhesion Test: Prior to delivery of composite wall panel system, perform test on adhesives and sealants per ASTM D3359. Test each adhesive and sealant utilizing specified panel finish.
   1. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as specified in Division 07 Section "Joint Sealants."

F. Source Quality Control: Obtain all preformed metal siding and accessories from the same manufacturer. This manufacturer shall be specialized in “dry gasketed floating plate" panel system detailing and fabrication with minimum of five years documented experience in similar size projects. Submit representative projects spanning this time frame along with the quantity of panel system supplied.

G. Allowable Installation Tolerances: Provide wall panel/girt/support/anchorage complying with the following:
   1. 1/4-inch maximum deviation from theoretical girt plane in 20 feet-0 inches both vertically and horizontally.
   2. Maximum Custom Panel Face Panel Alignment Variation: 1/4-inch in 40 feet-0 inches.
   3. Corners shall be within 1/8-inch of theoretical girt plane.
   4. Wind Load Girt Deflection: L/180; 3/4-inch maximum
   5. Vertical Girt Deflection: L/360, 1/2-inch maximum
   6. Girt vertical slip connections are required when spandrel beam vertical deflection exceeds 1/4-inch in the length of the horizontal panel.

7. All support members shall be hot-rolled shapes.

H. Allowable Production Tolerances: Provide the following:
   1. Panel Bow: Maximum 0.1 percent of panel dimension in width and length
   2. Width or Length: 0.125 inches
   3. Thickness: 0.008 inches
   4. End Squareness: 0.25 percent of panel width
   5. Camber: 0.12 inches

I. Coordination: Panel system shop drawings shall be coordinated with references to benchmark elevations and horizontal controls provided by GC/CM with all the other adjacent exterior wall trades drawings to including but not limited to:
   1. Exterior Studs for ceiling system: 16 ga minimum.
   2. Framing support for wall system shall be 8-inches deep and comply with the performance requirements specified herein.
   3. Fenestration: Windows, storefront and curtain walls, louvers.
   4. Air/water barriers and flashing to openings, roofing and adjacent materials.
   5. Release into production: identify how areas of work are best suited to be released for fabrication to avoid unnecessary production delays:
      a. Verify prior to fabrication: after verifying the construction of the substrate is compliant with contract drawings and coordinated shop drawings.

J. Secondary Supports Design
   1. Design, fabricate, and install secondary structural components of the metal cladding system, integrated louvers, integrated window units and other openings with a factor of safety not less than 1.5 (basis for design calculations shall be 1.5 times the maximum design wind pressure), such that failure of any panel component shall not occur at less than 1.5 times the maximum design wind pressure. Failure is defined as breakage, component disengagement, or permanent distortion.

K. Pre-installation Conference:
   1. Prior to the installation of preformed metal siding, integrated components, and associated Work, Contractor shall schedule and meet at the site with the preformed metal siding installer, the installer of each component of associated Work, the installers of structural girts and other substrate construction to receive Preformed Metal Siding Work, the installers of other Work in and around siding which must follow the preformed metal siding Work, including mechanical Work, Engineer and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to the preformed metal siding Work, including but not necessarily limited to, the following:
      a. Review project requirements, including Drawings, Specifications and other Contract Documents.
      b. Review required submittals, both completed and yet to be completed.

c. Review status of substrate including alignment, structural loading limitations and similar considerations.
d. Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
e. Review required inspection, testing, certifying and accounting procedures.
f. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
g. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.
h. Review procedures needed for protection of Performed Metal Siding Assemblies during the remainder of the construction period.

2. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.
3. Record any revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them to the Engineer

L. Fire-Test-Response Characteristics per ASTM E 84 or UL Standard 723:
1. Flame spread index: 25 or less.
2. Smoke developed index: 450 or less.

M. FMG Listing: Class 1 Insulating Wall or Ceiling Panel per FMG 4880

N. Job Mock-Up:
1. Before proceeding with final purchase of materials and fabrication of preformed metal siding components, prepare a three separate mock-ups as indicated on the contract documents for the Work including all components shown, indicating the final relationship and configurations of the various parts and components of the Work and the workmanship quality which shall be achieved in the Work.
2. Include all items that are part of the preformed metal siding system including, but not limited to, metal coping and flashing where indicated. Provide a sample area of as indicated on the contract drawings.
3. Incorporate materials and methods of fabrication and installation which are identical with project requirements.
4. Build three mock-up that will be modified as required to obtain Engineer's acceptance of the Work in conformance with the details indicated.
5. Mock-ups shall incorporate details of wall panel system. Demonstrate methods and details of installation. Show details of gasketed return vertical joints, penetrations, doors, windows, louvers, pipe openings, inside and outside corners, top and bottom of wall, horizontal and vertical joints.
6. Preformed Metal Siding Work which proceeds without an approved job mock-up shall be stopped, removed and re-installed, without question from Contractor, after job mock-up approval, at no additional expense to the Owner.

1.04 SUBMITTALS

A. The Contractor shall submit the following in accordance with the requirements of the General Conditions as it relates to Contractor's Working Drawings, Design and Shop Drawings and Materials and Equipment; and the Specifications.

B. Action Submittals – Submit the Following:
   1. Samples: Submit for approval the following:
      a. Samples of each component and cut-away corner of preformed metal siding and trim complete with custom controlled uniform finish, 2 foot-0 inches long by 2 foot – 0 wide. Final selection of finish shall be made by Engineer from complete range finishes in order to match metal provided by other Sections of the work.
      b. Cut-a-way samples of corner section of each type of louver made from 12-inch lengths of full size components and showing the proposed details of joinery, anchorage, movement, glazing, flashing, and drainage and with specified finish, prior to fabrication of the Work.
      c. Architect reserves the right to require samples demonstrating design, detailing and fabrication techniques and workmanship for each auxiliary louver component and accessory, before fabrication proceeds.
      d. Provide anodized finish manufacturer’s complete color charts.
      e. Submit one sample minimum 24-inches by 12-inches.
      f. One of each type fastener employed, with statement of intended use.
      g. Samples will be reviewed by Engineer for color, finish and workmanship only. Compliance with all other requirements is the responsibility of Contractor.
   2. Shop Drawings
      a. Copies of manufacturer's Specifications, standard and custom detail drawings and installation instructions for preformed metal siding and trim.
      b. Profiles of preformed metal siding units, the details of forming, jointing, internal supports, anchorages, trim, flashing, and accessories. Show details of rain screen and condensate drainage at edges, terminations and penetrations of the Preformed Metal Siding Work drawn at 1-1/2 inch scale. Accurately represent the conditions where the Work of this Section interfaces with other materials and construction systems such as door, window, and parapet construction. Show completely dimensioned small-scale layouts and elevations of entire Work drawn at 1/4 inch scale with details referenced from these elevations.
      c. Show location, extent and accurate configuration and profile of all items required to be built into the Work, which penetrate the Work or which are mounted on the Work.
      d. Completely dimensioned isometric drawings of details of all custom transition flashings, required for the Work drawn at 1-1/2 inch scale.
      e. Completely dimensioned plans, elevations and details showing all support system components and required adjustable anchorage for the entire preformed metal siding Work and other inter-related component systems such

as window and doors specified in other Sections. Support system structural performance calculations and anchorage drawings shall be prepared, signed and stamped with the seal of a Licensed Professional Engineer licensed to practice in the State of New York and recognized as an expert in the specialty involved.

f. Provide drawings coordinating the Work of this Section with adjacent Work.

C. Delegated Design: Design metal panel system, soffit, and associated components including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated. Include design of light gauge metal framing support for insulated metal panels and soffit panels.

D. Information Submittals: Submit the Following:
   1. Certificates: Provide copies of material purchase receipts, signed by a certified and licensed Notary Public, verifying that material purchased for the Work complies with material designations specified as confirmed by approved Working Drawings.
   2. Test Reports:
      a. Indicate compliance of products with requirements, from a qualified independent testing agency.
      b. Adhesion and compatibility test data and detailed drawings indicating structural silicone sealant performance and calculations indicating that sealant joints have been detailed and fabricated in compliance with silicone sealant manufacturer's most conservative industry-accepted recommended guidelines for dissimilar metal adhesion.
      c. Performance calculations for the structural silicone joints shall be prepared, signed and stamped with the seal of a Licensed Professional Engineer, licensed to practice in the State of New York, and recognized as an expert in the required Work.
   3. Product Data: Manufacturer’s data sheets for metal wall panels and accessories, as well as the following integrated components:
      a. Integrated window system.
      b. Integrated louvers, including integrated through-tube supports
      c. Concealed Fastener Metal Panel
      d. Conductor Head and Leaders
      e. Secondary metal framing, including integrated through-tube supports

E. Closeout Submittals: Submit the Following:
   1. Warranty: Submit for review copies of written warranty agreeing to replace preformed metal siding system and integrated components which fail to perform as specified.
   2. Maintenance data.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials:

1. Deliver preformed metal siding and all accessories dry and undamaged, with manufacturer's protective coating intact and in unopened, undamaged packages bearing original intact factory labels.
2. Panels which are damaged during delivery or while being unloaded shall not be stored on site. Remove such panels from site and replace panels with new, undamaged material.

B. Storage of Materials:
1. Store preformed metal siding and accessory materials in a manner that will protect strippable coating from exposure to sun and condensation; with good air circulation around each piece.
2. Store Preformed Metal Siding and accessory materials under tarpaulin covers and in an area protected from dirt, damage, weather and from the construction activities of all Contractors. Do not store outside or allow panels to become wet or soiled in any way while on site. Do not store pallet crates directly on the ground; materials must be raised sufficiently off the ground to prevent it from being flooded. Provide sufficient clearance between enclosure and system components for air circulation and for protection from windblown rain.
3. Do not store in contact with concrete, earth or other materials that might cause corrosion, staining, scratching or damage to finish or panel faces or edges. Do not erect panels which become dented, scratched or damaged in any way. Remove such panels from site and replace with new, undamaged material at no additional expense to the Owner. Damaged panels erected into the finished Work shall be removed immediately, and without question, by Contractor.
4. If crated system components become wet, remove all system components from the pallet crate immediately, separate and allow to dry under protective cover meeting the requirements of this Specification.

C. Handling of Materials:
1. Do not subject preformed metal siding and accessory materials to bending or stress. Do not carry or transport panels in the horizontal (flat) position. Hold panels upright on edge when handling.
2. Do not damage edges or handle material in a manner that will cause scratches, warps, or dents.
3. Panels which are damaged during erection shall be removed from site and replaced with new, undamaged material.

1.06 JOB CONDITIONS

A. Field Measurements: Verify window, louver, and other openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.07 SUBSTITUTIONS

A. Do not change material gage, or construction details after Working Drawing approval by Architect.

B. Provide gages of material specified for all Work or of heavier gage if calculations based on performance criteria submitted as part of Working Drawing approval process indicates the need for heavier gage material. All such substitutions shall be at no additional expense to Owner. Where compliance with performance criteria indicates that materials of lesser gage may be adequate, provide specified gage.

1.08 WARRANTIES

A. Warrant materials and workmanship for a period of two years from the date of Final Acceptance by the Owner against defects in workmanship and materials.

B. Warrant the preformed metal siding Work watertight for five years from date of Final Acceptance by the Owner.

C. Written warranty signed by paint manufacturer and/or applicator warranting that the painted finish will not develop excessive fading or excessive non-uniformity of color or shade, and will not crack, pit, peel, corrode, or otherwise fail as a result of defect in materials and workmanship. Warrantor will further guarantee to repair or replace defective work during a (twenty) year period following substantial completion of the work. Upon notification of defects within the warranty period, make necessary repairs or replacement at the convenience of the owner.

D. Submit written warranty agreeing to replace (integrated) louver which fails in materials or workmanship within three years of the date of Final Acceptance. Failure of materials or workmanship shall include, but is not limited to, excessive leakage or air infiltration, excessive deflections, deterioration of finish or metal in excess of normal weathering, and defects in accessories, weather-stripping, and other components of the Work.

E. Provide written warranty to the owner that all integrated units will be free of defective materials or workmanship for a period of one year from date of installation.

PART 2 – PRODUCTS

2.01 SYSTEM PERFORMANCE

A. System Description:
   1. Provide metal wall panel system, including all aforementioned integrated components and accessories, meeting performance requirements as determined by application of specified tests by a qualified testing agency on manufacturer's standard assemblies.
      a. Maintain the visual design concept shown, and the technical requirements specified, including modules, profiles, alignment of components and requirements for face panels capable of movement independent from support frame movement, rain screen principle detailing, condensate drainage detailing, and finish.
      b. Provide complete structural performance calculations and Working Drawings for all grit system support members, adjustable anchors and all other support

and fasteners system components prepared, signed and stamped with the seal of a Licensed Professional Engineer licensed to practice in the State of New York and recognized as an expert in the specialty involved. Structural steel girts shown indicate maximum spacing and minimum size acceptable to Engineer. Contractor shall supply additional girts and different girt profiles if required by the preformed metal siding manufacturer at no additional expense to the Owner.

c. All additional support system components required for support, transition of materials, items and component systems associated with the preformed metal siding Work such as Window and door supports girts shall be at no additional expense to the Owner.

B. Performance Criteria:

1. Air infiltration: Maximum 0.06 cfm/sq. ft. (0.3 L/s per sq. m) per ASTM E 283 at a static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa), using minimum 10 by 10 foot test panel that includes horizontal and vertical joints.
2. Water Penetration, Static Pressure: No uncontrolled water penetration per ASTM E 331 at a minimum static differential pressure of 15 lbf/ sq. ft. (718 Pa), using minimum 10 by 10 foot test panel that includes horizontal and vertical joints.
3. Water Penetration, Static Pressure – 2-hour duration: Panel system shall demonstrate no water penetration when tested in accordance with ASTM E331 at 15 psf pressure differential for a two (2) hour duration to satisfy Building Code, Section 1403.2. Panel systems unable to demonstrate compliance with this requirement will require a separate weather resistive barrier, approved by manufacturer for fire performance, installed behind the wall panel system to comply with Building Code requirements.
4. Water Penetration, Dynamic Pressure: No uncontrolled water penetration per AAMA 501.1 at a minimum static differential pressure of 15 lbf/sq. ft. (718 Pa), using minimum 8-by-8 foot (3050-by-3050 mm) test panel that includes horizontal and vertical joints.
5. System Performance: A 3rd party test report utilizing the standard ASTM E 283, E 331 and AAMA 501 procedures following the test protocol described in AAMA 508-07 must be submitted prior to bid. Test panel must include a horizontal joint, with an imperfect air barrier.
   a. Bidders supplying panel systems that have not successfully passed AAMA 508-07 shall provide a backup system that meets the air and water infiltration values as listed above in sections.
6. Water Absorption: Maximum 1.0 % absorption rate by volume when tested according to ASTM C 209.
7. Structural Performance: Provide metal wall panel assemblies capable of withstanding the effects of indicated loads and stresses within limits and under conditions indicated, per ASTM E 72:
   a. Wind Loads: Determine loads based on uniform pressure, importance factor, exposure category, and basic wind speed indicated on drawings.

b. Limits of Deflection: Composite wall panel system shall withstand scheduled wind pressure with the following allowable deflection
    1) Maximum allowable deflection limited to L/180 deflection of panel perimeter normal to plane of wall with no evidence of failure.
c. Secondary Metal Framing: Design secondary metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."
    1) Flashing Seal Plate & IMV - Provide minimum 5-inch- wide bearing surface for metal wall panels
d. Windborne-Debris-Impact-Resistance Performance: Pass missile-impact and cyclic-pressure tests per ASTM E 1886 and ASTM E 1996 for Wind Zone indicated on Drawings.
    1) Large-Missile Test: For curtain wall located within 30 feet (9.1 m) of grade.
    2) Small-Missile Test: For curtain wall located more than 30 feet (9.1 m) above grade.
e. Seismic Performance: Comply with ASCE 7 Section 9, "Earthquake Loads."
f. Integrated Louvers: design all materials to withstand wind and snow loads as required by the applicable building code. Maximum allowable deflection for the louver structural members to be 1/180 or .75 inch, whichever is less. Maximum allowable deflection for the louver blades to be 1/120 or .50 inch across the weal axis, whichever is less.

8. Thermal Movements:
    a. Preformed metal siding: allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by thermal expansion and contraction.
    b. Louvers: Provide acoustical louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar and heat gain and nighttime-sky heat loss.
        1) Temperature Change (Range): 20oF, ambient; 120of, material surfaces.
9. Thermal Performance: thermal-resistance (R) value, per ASTM C1363, with the following conditions:
    a. 15 mph exterior wind speed and still air on interior.
    b. Include side joint, standard fastening and integral reveals or profiling. Where reveals exceed the standards, the manufacturer shall provide similar testing to document any adjustments required to the standard conditions.
    c. R-value of 22 for a 3-inch thick panel with ½" reveal, taking into account integral reveals and profiling with resultant reduction in panel insulation thickness.
10. Fire Performance Characteristics: Provide metal composite wall systems with the following fire-test characteristics determined by indicated test standard as applied by UL or other testing and inspection agency acceptable to authorities having jurisdiction.

a. Surface-Burning Characteristics: Provide metal composite wall system panels with the following characteristics when tested per ASTM E 84.
   1) Flame spread index: 25 or less
   2) Smoke developed index: 450 or less
b. Intermediate Scale Multistory Fire Test: Representative mockup tested per NFPA 285.

11. Fire Resistance Ratings: Where indicated by design designations, provide metal wall panels tested per ASTM E 119 or UL Standard 263 by a testing and inspecting agency acceptable to authorities having jurisdiction.
    a. Fire Performance of Insulated Wall: Third Party Design Listing CSG/GWP 30-03
    b. Fire Performance of Insulated Wall: Class 1 wall panel per ANSI/FM 4880 & 4881.

2.02 MANUFACTURERS

A. Preformed Metal Siding "Insulated foam panel system, interior and exterior panel system" as manufactured by one of the following:
   1. CENTRIA Architectural Systems; 1005 Beaver Grade Rd., Moon Township, PA 15108-2944 (718) 314-4529
      a. Insulated Foam Panel System Product: CENTRIA, Formawall Dimension Series 3T
      b. Interior Panel System Product: CENTRIA, Profiled Series BR5-36.
      c. Exterior metal panel ceiling system, CENTRIA IW10A.
   2. The following additional manufacturers produce similar products as the above listed Basis of Design product. These manufacturers may provide products if they meet the performance requirements of this specification section. If products by these listed manufacturers do not meet the performance specified herein, these products must be submitted as a substitution in accordance with Division 1 requirements.
      a. Benchmark Architectural Series Design Wall 4000 series by Kingspan Group Company. Tel: (877) 638-3266
      b. Metl-Span; 1497 North Kealy, Lewisville, TX 75057; Tel: (877) 585-9969

B. Provide Acoustical Louvers, bird screens, blank-off panels, structural supports and attachment brackets herein specified and indicated on the drawings shall be as manufactured by the following or approved equal:
   1. Construction Specialties, Inc., 49 Meeker Avenue, Cranford, New Jersey 07016, Tel: 800-631-7379

2.03 MATERIALS

A. Foamed-Insulation-Core Metal Wall Panels: Factory-foamed-in-place horizontal and / or vertical wall panel system consisting of an exterior metal face sheet with interior metal liner panel forming a thermally separated profile, bonded to factory foamed-in-place halogen free insulated core, and with factory-sealed

tongue-and-groove and rainscreen-designed pressure-equalized horizontal side joint, configured with weep-hole-vented chamber to maintain equalized atmospheric pressure reducing potential for moisture drive into wall assembly, attached to supports using concealed fasteners.

1. Exclusions: The following do not meet the requirements of this Section:
   a. Laminated Insulated Panels, must be Foamed in place.
   b. Barrier wall-designed systems.
   c. Systems relying upon field-installed gaskets or wet seals to meet performance requirements.
2. Horizontal Panel – Horizontal Side Joint: Horizontal joints with positive drip edge, sloped drain shelf and integral venting to the exterior along the panel length to permit moisture drainage and to allow air to enter the pressure equalization chamber. Horizontal joint shall have a 2-3/8-inch baffle interlock and shall provide effective pressure equalization as demonstrated by testing specified herein.
3. Horizontal Panel – Vertical Panel to Panel Joint: Vertical joints for insulated metal panels shall be designed to allow moisture to be drained from the panel's horizontal joint. No end dam sealant is to be applied to the ends of the horizontal joint at the vertical joint location.
   a. Flashing Seal Plate - A continuous back-up flash behind the vertical joint is required with two beads of field applied non-curing butyl sealant between the panel and back up flashing for each panel. The field applied non-curing butyl sealant shall be married to the panel's shop applied non-curing butyl sealant within the panel's side joint.
   b. Insulated Metal Vertical Joint (IMV) - Vertical joint shall include an integrated, insulated metal vertical joint. The insulated metal vertical joint shall be recessed 1-3/16" deep and be 5/8" wide. The insulated metal vertical joint should not add exterior sightlines, contain exposed metal edges or exposed wet seals. The insulated metal vertical joint shall be constructed of 6# density polyisocyanurate foam insulation adhered to a metal face of the same material, gage and color.
4. Panel Ends: Flat Panels - Factory formed trim less ends, tabbed under panel horizontal shelf.
5. Panel Width: widths indicated on drawings.
6. Panel Profile: Flat in locations and sizes indicated.
7. Panel Reveals:
   a. Horizontal panels
      1) Flat Panels: 0.5" reveal
8. Panel thickness: 3-inch T (76 mm), flat.
9. Thermal-Resistance (R) Value: 3"-T flat - R-22 per ASTM C1363 Testing
10. Protective Coating: Immediately upon completion of the preformed metal siding fabrication, apply a transparent, color-coded, 2.5 mil thick strippable-film coating suitable for protection of the finish through commencement of erection, and capable of being easily hand-stripped from the surface at that time.

B. Metal Wall Panel Accessories

1. General: Provide complete metal wall panel assembly incorporating trim, copings, fascia, parapet caps, soffits, sills, inside and outside corners, and miscellaneous flashings. Provide manufacturer's factory-formed clips, shims, flashings, gaskets, lap tapes, closure strips, and caps for a complete installation. Fabricate accessories in accordance with SMACNA Manual.
2. Mitered Corners: Structurally-bonded horizontal interior and exterior trim less corners matching metal wall panel material, profile, and factory-applied finish, fabricated and finished by metal wall panel manufacturer.
    a. Welded, riveted, fastened, or field- fabricated corners to meet the requirements of this specification.
    b. Basis of Design: CENTRIA, MicroSeam Corners.
3. Extrusion Trim: Provide manufacturer-provided extruded trim for the following locations and as indicated on Drawings:
    a. Base trim.
    b. Coping.
    c. Panel installation perimeter.
    d. Opening perimeters.
4. Sealants: Type recommended by metal wall panel system manufacturer for application, meeting requirements of Division 07 Section "Joint Sealants."
5. Flashing Tape: 4-inch wide self-adhering butyl flashing tape.
6. Panel Attachment Clips: Concealed G-90 galvanized steel clip configured to prevent overdriving of fastener and crushing of foam core, with panel fasteners engaging both face and liner elements and mechanically attaching to panel supports. Clip configured also to be utilized without removing significant portions of the foam at each clip location.
7. Fasteners: Self-tapping screws, bolts, nuts, and other acceptable fasteners recommended by panel manufacturer. Where exposed fasteners cannot be avoided, supply corrosion-resistant fasteners with heads matching color of metal wall panels by means factory-applied coating.
8. Materials for Insulated Metal Panel:
    a. Stainless-Steel Face Sheet: ASTM A666, Type 304 architectural grade alloy.
        1) Face Sheet Thickness: 20 gage.
        2) Surface: Smooth, flat
        3) Finish: Brushed. No. 4.
    b. Metallic-Coated Steel Liner Sheet: Coil-coated, ASTM A 755/A 755M, 0.030 inch/22 gage thick.

C. Metal Panel Ceiling/Soffit System: Provide complete 304 stainless steel ceiling panel system supplemental support, delegate design using minimum 6-inch deep 16-gauge metal studs 16-inches on center with header framing at changes in direction of ceiling slope. Structural design based on performance requirements as indicated in Part 1 of this specification.
    1. Metal Ceiling Panels, General: Factory-formed, concealed fastener panels with interconnecting side joints, fastened to supports with concealed fasteners, when required to meet performance requirements.

2. Horizontal Joints: Horizontal Joints with drip edge and sloped drain shelf to provide positive water shed away from Panel Joinery.
3. Flush-joint profile with raised flat pan
    a. Basis of Design Product: CENTRIA, IW-10A
    b. Panel Coverage: 12 inches
    c. Panel Height: 1.50 inches
    d. Panel Gauge: 20ga
4. Flashing, Trim
    a. Provide 18 gauge 0.047-inch matching face sheet and vented flashings where required, and sheet metal contour closure trim components, support spacer strips, preformed cleat strips, base and drip flashings, closure and cleats, custom transition flashings, pan stops and closures, surrounds at openings, soffits, and similar components of the Work as indicated or as required for a permanently watertight and complete installation.
5. Anchors, Clips, Fasteners, and Cleats:
    a. Fastener Clips: 16 gage (0.051-inch) thick stainless steel
    b. Preformed and Prepunched Cleats: Provide minimum 2-inch wide stainless steel of shall provide a fold of 1/2-inch to be locked into the seam of folded edge of metal flashing with other end folded back over fastener heads.
    c. Fasteners: Provide self-tapping stainless steel fasteners with steel tips for use with pre-drilled holes.

D. Integrated Window Units: Thermally-improved fixed aluminum window units designed to integrate with metal wall panel profile and secondary support system without receptor channels or other flashing. System to be tested integrated with panels per the requirements of this section. Sash to accept 1 inch (25 mm) insulating glass units.
1. Basis of Design: CENTRIA Formavue FV400HR Integrated Window System or approved equal.
    a. System Depth: 2-1/2 inches, Sill 3-1/2 inches.
    b. System Depth: 2-1/4 inch (184 mm) without steel through-tube supports.
    c. Sightlines: Head: 3 inch (76 mm); Sill: 3 inch (76 mm); Mullions: 3 inch (76 mm).
2. Configuration: As indicated on the contract drawings.
3. Mullions: full depth
4. Frame: Weathered joints are shop assembled; Thermally-improved 6063-T5 aluminum extrusions; fully integrated with panel joinery; No receptors, inside glazed.
5. Interior and Exterior: Finish, Exterior: 100% Fluoropolymer Resin Powder Coat System. Finish thickness to be 1.5 to 3.0 mils. Finish to allow zero VOCs to be emitted into facility of application or at job site. Finish to adhere to a 4H Hardness rating.
6. Glazing: as specified in Section 08800 Glass and Glazing.

E. Integrated Wall Louver Units
1. Manufacturers/Products:

a. Product: C/S Louvers by Construction Specialties, Inc.; 8-inch deep Sightproof Fixed Acoustical Louver Model A-8370. Louvers to be supplied with 4" (101.6mm) high by full depth sill flashings formed from minimum 0.050" (1.27mm) thick aluminum. Sill flashings to have welded side panels.
b. Products equal to the C/S materials may be offered providing that the manufacturer and materials are pre-approved at least 10 working days before the bid date. Acceptable manufacturers include:
    i. Construction Specialties, basis-of-design model A-8370
    ii. Greenheck.
    iii. Arrow United.
    iv. Nailor.
c. Finish: Two-coat 70% PVDF fluoropolymer resin, AAMA 2605 compliant finish, with integrated Fluoromarine primer.

2. See section 10200- HVAC Louvers, for additional information.

F. Bird Screen:
1. Unless otherwise indicated, all louvers to be furnished with mill finish bird or insect screens.
2. Screens to be 5/8" (15.9mm) mesh, 0.050" (1.27mm) thick expanded and flattened aluminum bird screen secured within 0.055" (1.40mm) thick extruded aluminum frames. Frames to have mitered corners and corner locks.

G. Insulated Blank-Off Panels
1. Furnish as specified and where indicated on the drawings. Blank-off panel systems to be fabricated and installed on the louver by the louver manufacturer.
    a. Basis-of-Design: Blank-Off Insulated and Sheet Model IBO-3S manufactured by Construction Specialties for use with Construction Specialties Architectural Louvers.
2. Custom fabricated blank off panels factory sealed and quality tested. Includes independent 0.50" aluminum sheet forming the primary air and water seal, which is adhered with butyl tape and whose perimeter is fully sealed and tooled with weather silicone. Any insulated blank-off panels are to be fastened independently to the rear side of the louver, through dry zones of the framing and NOT penetrating any part of the primary sealing sheet.
3. 3-inch (76.2mm) thick insulated blank-off panels model IBO-3S, fabricated with hydrophobic fire rated mineral wool core having an R-value of 4 per inch (0 F*ft2 *h/Btu), faced on both sides with 0.032" (0.81 mm) thick aluminum sheet. Panel perimeter frame to be 0.080" (2.03mm) thick-formed aluminum channels. Panel frame to be mitered at the corners. Panels to be finished with standard black Kynar 500 minimum 1 mil (0.025mm) thick full strength 70% resin Fluoropolymer coating unless otherwise specified.

H. Secondary Metal Framing
1. Exposed Framing Components: General: Cold-formed metallic-coated steel sheet, ASTM A 653, G90.

2. Concealed Framing Components, General: Cold-formed metallic-coated steel sheet, ASTM C 645, Grade 50, with ASTM A 653/A 653M, G90 (Z180) hot-dip galvanized zinc coating.
3. Subgirts: C- or Z- shaped sections, 0.054-inch minimum.
4. Sill Channels: 0.054-inch (1.37-mm) minimum.
5. Hat Channels: 0.054-inch (1.37mm) minimum.
6. Steel vertical tube or 16 gauge metal stud structural supports for metal wall panel system: coordinate with panel system components, engineered to meet project structural design requirements, and finished to match panel interior finish, of size indicated on approved shop drawings.

PART 3 - EXECUTION

3.01 INSPECTION

A. The Contractor shall examine the alignment of the substrate before erection of the preformed metal siding system Work (including all integrated components, framing, supports, and accessories) begins and notify Architect in writing of unsatisfactory conditions. Do not proceed with the preformed metal siding system Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

B. Verify to Architect gage of preformed metal siding panels and flashing brought to the Site by actual measurement of on-site material in the presence of Engineer.

3.02 PREPARATION

A. Girts and anchorage shall be brought into final alignment by preformed metal siding installer.

B. Girts shall be adjusted to comply with allowable tolerances specified.

C. Prior to submitting Shop Drawings, verify all relevant dimensions and site conditions. Do not delay project progress; where exact dimensions cannot be confirmed before fabrication, allow for reasonable adjustment. Confirm in Shop Drawing submission that shown conditions match actual site conditions. If discrepancies exist, clearly identify them in the submission and notify the Architect immediately. Provide recommendations for corrective work, if necessary, to maintain compliance with the design intent.

3.03 INSULATION LIMITATIONS

A. General:
1. Provide thermal expansion for running trim, flashings, copings and other items exposed for more than 10 feet-0 inches continuous length. Maintain a watertight installation at expansion seams. Locate expansion seams at 10 feet - 0 inch intervals, and 2 feet - 0 inch each side of corners and intersections.
2. Fabricate and install the Work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves and

avoidable tool marks, considering the temper and reflectivity of the metal. Provide uniform, neat seams with minimum exposure of metal.

3. Conceal fasteners and expansion provisions in exposed Work, and locate so as to minimize the possibility of leakage. Provide expansion joint systems using only metal components.
4. Provide integrally installed, concealed cleat-type anchorages for metal copings and flashings and trim, spaced no greater than 12 inches on center and arranged to relieve stresses from building movement, and thermal expansion and contraction.
5. Miscellaneous penetrations may be cut into the Work in the field. All such field cutting shall be made only by the installer of the preformed metal siding and shall be approved by Engineer before cutout in made.
6. Verify dimensions of supporting structure at the site by accurate field measurements so that the work will be accurately designed, fabricated and fitted to the structure.
7. Protection of Aluminum from Dissimilar Materials: Coat all aluminum surfaces in contact with dissimilar materials such as concrete, masonry, steel and other metals as specified in Section 09900, Painting.

B. Preformed Metal Siding System
   1. Comply with preformed metal siding manufacturer's instructions for assembly, installation and erection of preformed metal siding. Install all materials in accordance with approved Working Drawings and with all fasteners in concealed locations.
   2. Install preformed metal siding with the longitudinal configuration and joints in the horizontal position. Keep horizontal and vertical lines straight, level and plumb.
   3. Anchor component parts of preformed metal siding securely in place at each girt providing for necessary thermal and structural movement, and meeting wind loads specified.
   4. Pre-drill all fastener holes. Drill at an angle and use an extra-long drill in order to prevent scaring of panel and trim surfaces. Do not exceed fastener spacing recommended by the preformed metal siding manufacturer.
   5. Locate preformed metal siding joints as shown on approved Working Drawings. Use care in maintaining uniform width of joints at all locations.
   6. Fasten flashings and accessories 12 inches on center.
   7. Do not fabricate flashings, closures and associated trim at the Site.
   8. Install all special flashing and trim shapes, contour closure strips required to maintain complete weather tightness.
   9. Remove strippable protection coating immediately before erection. If surface of units are sticky, clean panels and trim before installation using product recommended by preformed metal siding manufacturer. After solvent cleaning, wash all surfaces with a mild detergent and water solution to remove any remaining solvent residue. Follow all environmental, safety and health precautions recommended by manufacturer.

C. Window Units:

1. Install window units in accordance with manufacturer's recommendations and approved shop drawings. Anchor supports to structure with approved anchors. Assemble wall components using gaskets, fasteners, and trim supplied by metal wall panel manufacturer. Separate dissimilar metals with manufacturer's approved coating.

D. Integrated Louvers
   1. Anchor louvers to the building substructure as indicated on architectural drawings.
   2. Erection Tolerances:
   3. Cut and trim component parts during erection only with the approval of the manufacturer or fabricator in accordance with his recommendations
   4. Locate and place louver units plumb, level, and in proper alignment with adjacent work.
   5. Use stainless steel expansion bolt anchors with stainless steel washers and neoprene gaskets. Use spring clips at all anchors to stop deflection of the louver frame. Provide anchors spaced 2 feet 0 inches on centers. Provide continuous aluminum angles for anchoring all operable louvers.
   6. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as shown.
   7. Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finishes and prime coats of paint so that there is no evidence of corrective Work. Return items which cannot be refinished in the field to the shop, make the required alterations, and refinish the entire unit, or provide new units, as determined by Architect.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: An independent testing and inspecting agency acceptable to Architect to perform field tests and inspections and to prepare test reports.

B. Water-Spray Test: After completing portion of metal wall panel assembly including accessories and trim, test 2-bay area selected by Architect for water penetration, according to AAMA 501.2. Wall areas should be tested as a routine QA procedure. Areas erected by each crew should be checked at various stages of erection.

C. Manufacturer’s Field Service: Engage a service representative authorized by metal wall panel manufacturer to inspect completed installation. Submit written report. Correct deficiencies noted in report.

3.05 ADJUSTING AND CLEANING

A. Set preformed metal siding plumb, level, and true to line, without warp or rack.

B. Set adjustable louver blades for uniform alignment in open and closed positions.

C. Adjust louvers so moving parts operate smoothly.

D. Clean exposed surfaces of preformed metal siding Work of every substance before leaving the Site after completion of installation. Comply with recommendations of both the preformed metal siding and coating manufacturer. Comply with written recommendations of the preformed metal siding manufacturer for cleaning the Work. Do not use abrasives or non-approved solvent cleaners. Test cleaning techniques on an un-used panel before employing cleaning technique in the Work.

E. Leave preformed metal siding and flashing perfectly flat, free from dents, burrs, scratches, holes or other blemishes. Refinishing scratches on the surface of the panels, flashing and all associated material, to be indistinguishable from adjacent un-scarred areas, will be permitted by Architect. If, after refinishing, damage remains visible when viewed from grade, or if finish of Work has been altered to the point where it appears different from adjacent Work, Contractor shall replace damaged work with new undamaged material at no additional expense to the Owner.

F. Do not erect components which have become scarred, chipped, discolored or otherwise damaged or defaced. System components which have holes, cuts, gouges, dents or exposed fasteners of any kind shall not be allowed to remain in the Work. Repairs, to correct such panels, shall not be approved by Engineer. Remove and replace with new material.

G. Louvers with dents, warps, gouges, or scratches shall be replaced with new louvers, at no additional cost to Owner.

H. At the completion of the Work, clean or replace adjacent work, marred by the Work of this Section.

I. Remove all materials and debris and leave the site of the Work in clean condition.

J. Remove temporary protective films. Clean finished surfaces as recommended by metal wall panel manufacturer. Clear weep holes and drainage channels of obstruction, dirt, and sealant. Maintain in a clean condition during construction.

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SECTION 07555

POLYVINYL CHLORIDE MEMBRANE ROOFING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. PVC Adhered membrane roofing system as specified herein shall include, but not be limited to, preparation of subsurface, polyvinyl chloride (PVC) membrane, cover board, roof insulation, roof flashing application, protection sheet, and appurtenances.

1.02 RELATED SECTIONS:

A. Section 06100 - Rough Carpentry

B. Section 07620 - Sheet Metal Flashing and Trim

C. Section 07710 - Roof Specialties

D. Section 07920 - Joint Sealants

1.03 REFERENCES

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

C. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

D. ASTM D1079 - Standard Terminology Relating to Roofing and Waterproofing. For definition of terms related to roofing work not otherwise defined in the section.

E. ASTM D1621 - Standard Test Method for Compressive Properties Of Rigid Cellular Plastics.

F. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.

G. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.

H. FM DS 1-28 - Wind Design; Factory Mutual System.

I. FM DS 1-29 - Roof Deck Securement and Above-Deck Roof Components; Factory Mutual System.

J. LTTR: Long Term Thermal Resistance, as defined by CAN-ULC S770.

K. PS 1 - Structural Plywood.

L. PS 20 - American Softwood Lumber Standard.

M. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials

N. UL - Underwriters' Laboratories Fire Resistance Directory

O. OSHA - Occupational Safety and Health Administration.

P. NRCA - National Roofing Contractor Association - Glossary of NRCA's "The NRCA Roofing and Waterproofing Manual."

Q. Glossary of Terms - Roof Consultants Institute "Glossary of Roofing Terms" for definition of terms related to roofing work in this Section.

R. Sheet Metal Terminology and Techniques: SMACNA Architectural Sheet Metal Manual.

S. Roofing Terminology: Refer to the following publications for definitions of roofing work related terms used in this Section:
   1. ASTM D 1079 "Terminology Relating to Roofing and Waterproofing."
   2. Glossary of NRCA's "The NRCA Roofing and Waterproofing Manual."
   3. Roof Consultants Institute "Glossary of Roofing Terms."

1.04 DESIGN CRITERIA

A. General: Installed roofing membrane and base flashing systems shall remain watertight; and resist specified wind uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Roofing materials shall be compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.

C. Wind Uplift Performance: Roofing system shall be identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist wind uplift pressure calculated in accordance with ASCE-7.
   1. Field-of-Roof Uplift Pressure: 80 lbf/sq. ft. (kN/sq. m).
   2. Perimeter Uplift Pressure: 103 lbf/sq. ft. (kN/sq. m).
   3. Corner Uplift Pressure: 141 lbf/sq. ft. (kN/sq. m).

D. FMG Listing: Roofing membrane, base flashings, and component materials shall comply with requirements in FMG 4450 and FMG 4470 as part of a roofing system and that are listed in FMG's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.

1. Roofing system shall comply with FM requirements:
2. Fire/Windstorm Classification: Class 1A-90
3. Hail Resistance: Moderate Hail.

E. UL Listing: The product provided by this Section shall be a UL class A fire rated roof system.

F. Thermal Performance: Roof system will achieve a minimum R value not less than 30 or as indicated on the drawings.

G. Drainage: Provide a roof system with positive drainage where all standing water dissipates within 48 hours after precipitation ends.

1.05 SUBMITTALS

A. The Contractor shall prepare and submit for approval catalog cuts and reference materials in accordance with the General Conditions and Shop Drawings.

B. Product Data: The Contractor shall submit copies of specifications, installation instructions and general recommendations from the modified bitumen membrane roofing manufacturer. Manufacturer's data substantiating that the materials comply with the requirements shall be included.

C. Applicator Approval: The Contractor shall submit a document from the roofing manufacturer stating that the subcontractor is an approved applicator for the specified materials. Include the following submittals for approval of the applicator:
1. Two 3 inch x 5 inch samples of the primary roofing and flashing sheets.
2. Latest edition of the roofing system manufacturer's specifications and installation instructions.
3. Descriptive list of the materials proposed for use.
4. Evidence of Underwriters' Laboratories Class A acceptance of the proposed roofing system (including mopping asphalt or cold adhesive) without additional requirements for gravel or coatings. No other testing agency approvals will be accepted.
5. Letter from the proposed primary roofing manufacturer confirming the number of years it has directly manufactured the proposed primary roofing system under the trade name and/or trademarks as proposed.
6. List of three (3) of the manufacturer's projects, located in the United States, of equal size and degree of difficulty which have been performing successfully for a period of at least five (5) years.
7. Complete list of material physical and mechanical properties for each sheet including: weights and thicknesses; low temperature flexibility; breaking load; ultimate elongation; dimensional stability; compound stability; granule embedment.
8. Specimen Warranty: Submit prior to starting work.

9. Pre-Installation Notice: Copy to show that manufacturer's required Pre-Installation Notice
10. Installation Notice (PIN) has been accepted and approved by the manufacturer.

D. Detail Drawings: Provide roofing system plans, elevations, sections, details, and details of attachment to other Work, including:
1. Base flashings, cants, and membrane terminations.
2. Tapered insulation, including slopes.
3. Crickets, saddles, and tapered edge strips, including slopes.
4. Insulation fastening patterns.

E. Verification Samples: Provide for each product specified.
1. Maintenance Data: Refer to Manufacture’s latest published documents.
2. Guarantees: Special guarantees specified in this Section.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and is eligible to receive the specified manufacturer's guarantee.

B. Manufacturer Qualifications: Qualified manufacturer that has UL listing and FMG approval for roofing system identical to that used for this Project.

C. Testing Agency Qualifications: Independent testing agency with the experience and capability to conduct the testing indicated, as documented in accordance with ASTM E 548.

D. Test Reports:
1. Roof drain and leader test or submit plumber’s verification.
2. Core cut (if requested).
3. Roof deck fastener pullout test.

E. Source Limitations: Obtain all components from the single source roofing system manufacturer guaranteeing the roofing system. All products used in the system shall be labeled by the single source roofing system manufacturer issuing the guarantee.

F. Fire-Test-Response Characteristics: Roofing materials shall comply with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, [FMG], or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.
1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.
2. Fire-Resistance Ratings: ASTM E 119, for fire-resistance-rated roof assemblies of which roofing system is a part.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.08 PROJECT CONDITIONS

A. A. Weather Limitations: Proceed with installation only when current and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written instructions and guarantee requirements.

1.09 GUARANTEES

A. Provide manufacturer's system guarantee equal to Johns Manville's Peak Advantage No Dollar Limit Roofing System Guarantee.
   1. Single-Source special guarantee includes roofing plies, base flashings, liquid applied flashing, roofing membrane accessories, roof insulation, fasteners, cover board, vapor retarder, walkway products, manufacturer’s edge metal products], and other single-source components of roofing system marketed by the manufacturer.
   2. Guarantee Period: 20 years from date of Substantial Completion.
   3. Wind Rider: Guarantee shall not exclude coverage for wind events up to three second gust to 130 mph.
   4. Hail Rider: Guarantee shall have no exclusions for hail events up to 1.5 inches.
   5. Accidental Puncture Rider: Guarantee shall provide coverage for accidental puncture for up to 16 billed repair hours per year for the life of the guarantee.

B. Installer’s Guarantee: Submit roofing Installer's guarantee signed by Installer, covering Work of this Section, including all components of roofing system, for the following guarantee period:
   1. Guarantee Period: Two Years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 POLYVINYL-CHLORIDE ROOFING MEMBRANE – PVC FLEECE BACK

A. PVC Sheet: ASTM D 4434, Type III, fabric reinforced that contains KEE (Elvaloy) to reduce plasticizer migration. Bases of Design: JM PVC FB 135
   1. Certification, by letter, stating that the formulation has a minimum 15 years of performance history in North America.
   2. Thickness: Total-135 mil (2.03 mm), minimum: PVC Membrane 80 mils
   3. Color: White.

B. Acceptable Manufacturers:
   1. Johns Manville PVC FB 135 KEE Roofing Systems
   2. GAF- EverGuard® PVC XK 80 mil Fleeceback Roof Systems
   3. Flex FB 80 Plus Elvaloy Roofing Systems

2.02 AUXILIARY ROOFING MATERIALS – SINGLE PLY

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
   1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's sheet flashing of same material, type, reinforcement, thickness, and color as sheet membrane.

C. Sheet Flashing: Manufacturer's unreinforced sheet flashing of same material as sheet membrane.

D. Bonding Adhesive for Flashing: Manufacturer's standard solvent based bonding adhesive for membrane, and solvent-based bonding adhesive for base flashings. Basis of Design: JM PVC Membrane Adhesive (Low VOC)] or approved equal

E. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

F. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel bars, with anchors.

G. Metal Battens: Manufacturer's standard aluminum-zinc-alloy, pre-punched.

H. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and furnished by roofing system manufacturer.

I. Membrane Adhesive for PVC FleeceBack membrane; Product: JM Roofing System Urethane Adhesive. Bases of Design JM RSUA.

J. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, termination reglets, cover strips, sealants, and other accessories.

2.03 AUXILIARY ROOFING SYSTEM COMPONENTS

A. Provide Penthouse Elevator Vent as specified in Section 10200 – Louvers. Allow access for control wire for fire alarm system to be installed by others.

B. Metal Flashing Sheet: Metal flashing sheet is specified in Section 07620 - Sheet Metal Flashing and Trim.

2.04 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads sourced from membrane roofing system manufacturer. Basis of Design: JM PVC Heavy-Duty Walkpad.

2.05 COVER BOARD

A. Top Layer: Georgia-Pacific Corp. Dens-Deck
   1. Provide Gypsum Core panel acceptable to the roofing system manufacturer and complying with Factory Mutual requirements for FM approval for Class 1.
   2. Gypsum core panel shall be 1/2th inch thick primed fire stop Type X, silicone treated gypsum core with fiberglass matte facing on both sides, Dens-Deck roof board manufactured by Georgia-Pacific Corp.
   3. Gypsum core panel shall be fire resistant with zero flame spread and zero smoke developed when tested per ASTM E-84 tunnel test method.

B. Adhesive for Cover Board Attachment: Type as required by roof membrane manufacturer for roofing system and warranty to be provided; use only adhesives furnished by roof membrane manufacturer. Product: JM RSUA

2.06 ROOF INSULATION

A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.
   1. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Basis of Design: ENRGY 3.
   2. Thickness: minimum 5.25-inches
   3. Size: 48 inches (1220 mm) by 48 inches (1220 mm), nominal.
   4. R-Value (LTTR): 5.7 per inch, for an overall LTTR = 30 minimum.
   5. Compressive strength: 20 PSI (138 KPA) when tested in accordance with ASTM C1289.
   6. Ozone Depletion Potential: Zero; made without CFC or HCFC blowing agents.

7. Recycled content: 19 percent post-consumer and 15 percent post-industrial, average.

2.07 TAPERED INSULATION

A. Tapered Insulation: ASTM C 1289, provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48), unless otherwise indicated. For crickets shall slope at 1/2 inch per 12 inches (1:24), unless otherwise indicated.

2.08 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

B. Provide factory preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

C. Insulation Adhesive: Manufacturer's two component urethane adhesive formulated to adhere insulation to substrate. Product: JM RSUA

D. Wood Nailer Strips: Comply with requirements in Section 06100 Rough Carpentry.

2.09 VAPOR RETARDER

A. Polyethylene-Reinforced Vapor Retarder: Provide Tri-laminate woven polyethylene, nonslip, UV-protected top surface with temporary weather protection for 90 days capability as stated by the manufacturer. Vapor retarder shall be self-sealing SBS rubber and asphalt blend. Provide Johns Manville Barrier SA or approved equal with the following compliance requirements:

PHYSICAL PROPERTIES		ASTM TEST METHOD	VAPOR BARRIER	
			MACHINE DIRECTION	CROSS-MACHINE DIRECTION
STRENGHT	TEAR RESISTANCE	D 5601	8 4 LBF (375 N)	90 LBF (400 N)
	TENSILE STRENGTH	D 5147	64 LBF/IN. (11.3 KN/M)	88 LBF/IN. (15.4 KN/M)

	STATIC PUNCTURE	D5602	90 LBF (400 N)	
LONGEVITY	LOW TEMP. FLEXIBILITY	D 5147	-31°F (-35°C)	
	THICKNESS	D 5147	30 MIL (0.8 MM)	
	LAP ADHESION	D 1876	11.4 LB/IN (2000 N)	
	ELONGATION AT PEAK LOAD AT 0°F (-18°C)	D 5147	52%	24%
PERFORMANCE	WATER ABSORPTION	D 5147	0.1% MAX.	
	PEEL RESISTANCE	D 903	6.9 LB/IN (1200N)	
	WATER VAPOR PERMEANCE	E96 (PROCEDURE B)	0.017 PERM (1.30 NG/PA-SEC-M^2	
	AIR PERMEABILITY		< 0.007 L/SEC-M2 (1.4 X 10-3 FT3/MIN. FT2)	

2.10 EDGE METAL COMPONENTS

A. Coping System: Manufacturer’s factory fabricated coping consisting of a base piece and a snap-on cap. Provide product from single-source roofing system supplier that is included in the manufacturer's warranty. Basis of design: Johns Manville Presto-Lock Coping.

B. Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section "Sheet Metal Flashing and Trim."

2.11 CONCRETE PRIMER

A. Provide concrete primer as required for complete installation in accordance with manufacturer’s warranty requirements. Provide JM Concrete Prime or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions for compliance with requirements affecting performance of roofing system.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and remove from substrate sharp projections, dust, debris, moisture, and other substances detrimental to roofing installation in accordance with roofing system manufacturer's written instructions.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

C. Prime surface of concrete deck with asphalt primer at a rate recommended by roofing manufacturer and allow primer to dry.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 VAPOR-RETARDER INSTALLATION

A. Prime the substrate board with JM Concrete Primer at the rate of 1 gallon per 100 sq. ft. Allow to dry thoroughly. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

B. Thermally fuse as per the manufacturer’s recommendation and details the SBS Vapor Retarder to the primed substrate board lapping end laps 6 inches and side laps 3 inches.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.04 INSULATION AND COVER BOARD INSTALLATION

A. Coordinate installation of roof system components so insulation and cover board is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system manufacturer's written instructions for installation of roof insulation and cover board.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation boards with long joints in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with like material.

E. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall thickness is 2-inches or greater, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

F. Trim surface of insulation boards where necessary at roof drains so completed surface is flush and does not restrict flow of water.

G. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

H. Adhered Insulation: Install each layer of insulation and cover board and adhere to substrate as follows:
   1. Install each layer in a two-part urethane adhesive according to roofing system manufacturer's instruction.

I. Set thermal layer in a serpentine fashion using 2 part urethane insulation adhesive applied in 3/4 inch wide beads at the following minimum rates:
   1. Field: Beads at 8 inch on center
   2. Perimeter: Beads at 4 inch on center
   3. Corner: Beads at 4 inch on center

J. Place board into the adhesive while it is still tacky.
   1. If adhesive reaches its tack-free state, remove and re-apply adhesive.

K. Press the thermal layer into the adhesive to a firm and uniform bearing.
   1. Use ballast (sand bags or bagged rocks) on all four corners of the board for a minimum of 30 minutes to ensure contact of material and adhesive, if necessary.

L. Keep insulation absolutely dry at all times. Discard insulation that contains moisture.

M. Install only as much insulation as can be covered with roofing membrane the same day.

N. Repair any defects or installation errors prior to next phase of roof system installation.

3.05 ROOFING MEMBRANE INSTALLATION, GENERAL

A. Install roofing membrane in accordance with roofing system manufacturer's written instructions, applicable recommendations of the roofing manufacturer and requirements in this Section.

B. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.

C. Where roof slope exceeds 1/2 inch per 12 inches (1:24, contact the membrane manufacturer for installation instructions regarding installation direction and backnailing

D. Cooperate with testing and inspecting agencies engaged or required to perform services for installing roofing system.

E. Coordinate installing roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is imminent.
   1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
   2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
   3. Remove and discard temporary seals before beginning work on adjoining roofing.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.06 MEMBRANE INSTALLATION FOR FLEECEBACK SYSTEM

A. Install Johns Manville roofing membrane specification SP6PU-C/I in the areas over concrete. Install roofing according to membrane roofing system manufacturer's written instructions or these specifications whichever are more stringent. Unroll roofing membrane and allow to-relax before installing.

B. Start installation of roofing membrane in the presence of membrane roofing system manufacturer's technical personnel.

C. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Once the membrane has been properly positioned, fold the sheet back half of the sheet’s length.

E. Apply Roof System Urethane Adhesive in a ¾ (three quarters) bead in the following minimum pattern.
   1. Field: 8 inches on center
   2. Perimeter: 4 inches on center
   3. Corners: 4 inches on center

F. Mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.

G. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

H. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roofing membrane.
2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
    a. Remove and repair any unsatisfactory sections before proceeding with Work.
3. Repair tears, voids, and lapped seams in roofing membrane that do not meet requirements.

I. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

J. Mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.

K. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

L. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.
    1. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.

M. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure a watertight seam installation.
    1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roofing membrane.
    2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
        a. Remove and repair any unsatisfactory sections before proceeding with Work.
    3. Repair tears, voids, and lapped seams in roofing membrane that do not meet requirements.

N. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

O. Install roofing membrane and auxiliary materials to tie into existing roofing.

P. Proceed with installation only after unsatisfactory conditions have been corrected.

3.07 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates in accordance with membrane roofing system manufacturer's written instructions.

B. Apply solvent-based bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with sheet flashing.

D. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

E. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.

F. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

G. Install manufacturer's Coping and/or Fascia as per the manufacturer's written instructions.

3.08 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Adhere with compatible adhesive and heat weld walkway products to substrate according to roofing system manufacturer's written instructions. – PVC

B. Roof-Paver Walkways: Install heavy duty walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.09 FLOOD TEST

A. Membrane shall be allowed to cool, after which drains shall be plugged, and barriers installed to contain flood water.

B. Surface shall be flooded with a 2-inch head of water, set a 5-gallon pail with the same 2-inches of water on the flood test area and allowed to set for 24 hours. Surface shall be inspected for leaks, and membrane shall be repaired if leaks are found. After making repairs, system shall be retested. The bucket of water shall be used as a determination of any evaporation which may have taken place.

C. Repair or remove and replace components of roofing system where test results or inspections indicate that they do not comply with specified requirements.

3.10 PROTECTION AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

B. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

+ + END OF SECTION + +

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SECTION 07620

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install sheet metal flashing and trim.
   2. Extent of the sheet metal flashing and trim includes but not limited to:
      a. Complete systems of flashing and counterflashing at penetrations in roofing
      b. Miscellaneous system components such as cast-in-place and built-in-place reglets and other accessory components for complete watertight systems.
      c. Miscellaneous flashings not supplied by other Sections.
      d. Miscellaneous accessories, fasteners and incidental system components necessary for a complete water- and weather tight permanent installation complying with all governing codes and the requirements of FM approval rating Class 1-90 construction installation and the recommendations of FM 1-49, without relying upon sealants or other non-metallic detailing and fabricating techniques to achieve weather- and watertightness.
   3. The Work also includes:
      a. Providing openings in sheet metal flashing and trim to accommodate the Work under this and other Sections and building into the sheet metal flashing and trim all items such as sleeves, anchor bolts, inserts and all other items to be embedded in sheet metal flashing and trim for which placement is not specifically provided under other Sections.
      b. Providing openings in sheet metal flashing and trim to accommodate the work under other contracts and assisting other contractors in building into the sheet metal flashing and trim, piping, conduits, inserts and all other items required to penetrate sheet metal flashing and trim under other contracts.
   4. Types of products required include the following:
      a. Stainless steel sheet flashing.
      b. Shop-formed, snap-lock metal coping flashing and shop-formed cap flashing requiring no exposed fasteners or splice-plates.
      c. Surface-mounted reglets and counterflashing.
      d. Built-in-place reglets and counterflashing.
      e. Through wall and waterproofing course flashing.
      f. Flexible masonry flashing
      g. Drip trays at mechanical equipment and piping.
      g. Miscellaneous flashing not supplied under other Sections.
      h. Complete selection of custom and premium custom-blended full-strength, polyvinylidene fluoride finishes and colors with extended life topcoat.

i. Protective strippable film on all surfaces of snap-lock metal coping, extruded aluminum gravel stops, fascia extensions and metal coping corner and transition flashings.
j. Miscellaneous accessories, fasteners, cleats and incidental sheet metal flashing and trim system components necessary for a complete installation.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the sheet metal flashing and trim Work.
2. Work advanced without sheet metal flashing and trim items that are specified to be cast-in-place or built-in-place as the Work advances, shall be stopped, demolished and rebuilt incorporating specified sheet metal flashing and trim Work, at no additional cost to Owner.

C. Related Sections:
1. Section 03300, Cast-In-Place Concrete.
2. Section 04201, Unit Masonry Construction.
3. Section 04220, Concrete Unit Masonry
4. Section 07111, Bituminous Dampproofing.
5. Section 07461, Preformed Metal Siding.
6. Section 07555, PVC Membrane Roofing.
7. Section 07920, Joint Sealants.

1.02 REFERENCES

A. Standards referenced in this Section are listed below:
1. ASTM A240, Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.
2. ASTM A666, Specification for Annealed or Cold-Worked Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar.
3. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
4. ASTM B 209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
5. ASTM D 412, Test Methods for Vulcanized Rubber and Thermoplastic Rubbers - Tension.
6. ASTM D 522, Test Methods for Mandrel Bend Test of Attached Organic Coatings.
7. ASTM D 523, Test Method for Specular Gloss.
8. ASTM D 624, Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
9. ASTM D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
10. ASTM D 968, Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.

11. ASTM D 1308, Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
12. ASTM D 2240, Test Method for Rubber Property - Durometer Hardness.
13. ASTM D 2244, Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
14. ASTM D 2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
15. ASTM D 3363, Test Method for Film Hardness by Pencil Test.
16. ASTM D 3363, Test Method for Film Hardness by Pencil Test.
17. ASTM D 4214, Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
18. FM I-49, Factory Mutual Architecting Corporation, Perimeter Flashing.
19. National Roofing Contractors Association, (NRCA). Low-Slope Membrane Roofing Construction Details Manual.
20. Sheet Metal and Air Conditioning Contractors National Association, Incorporated, (SMACNA). SMACNA 1013, Architectural Sheet Metal Manual.
21. The Society for Protective Coatings, (SSPC). Paint 12, Cold Applied Asphalt Mastic (Extra Thick Film).

1.03 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Engage a single installer who is a recognized flashing and trim installer, skilled and experienced in the type of flashing and trim Work required, and equipped to perform workmanship in accordance with recognized standards so that there will be undivided responsibility for the performance of the Work. Submit name and qualifications to Architect along with at least three successfully completed Projects including names and telephone numbers of owners, architects and Architects, responsible for the project and the approximate contract price for flashing and trim work.
   2. The installer of the sheet metal flashing and trim Work shall be franchised or otherwise accepted in writing by the built-up bituminous roofing materials manufacturer for installation of fully guaranteed built-up bituminous roofing Work in accordance with these Specifications.

B. Performance Criteria:
   1. Sheet metal flashing and trim shall be permanently watertight, and not deteriorate in excess of manufacturers' published limitations.
   2. Comply with fabrication details recommended by SMACNA and the sheet metal flashing and trim manufacturers, as approved by Architect at time of Working Drawing submission.
   3. Provide completely weather- and watertight wall and roofing metal flashing systems. Contractor shall provide only the highest quality materials and methods of construction and installation as recommended by sheet metal flashing and trim

manufacturers in compliance with governing authorities and as approved by Architect at time of Working Drawing submission.

4. Work advanced without built-in sheet metal flashing and trim Work shall be stopped, removed and rebuilt at no additional expense to Owner, even if discovered only after walls and other materials are in-place and completed.

1.04 SUBMITALS

A. Action Submittals: Submit the following:
   1. Samples:
      a. 12-inch square samples of specified sheet metal flashing and trim metals.
      b. Each fastener type, clips, and support required, marked as to type of material and with their intended purposes in the work.
      c. Each item of gravel stop and coping system, demonstrating assembly of system joint components and fasteners, securely mounted to substrate simulating actual installation in the Work.
      d. Polyvinylidene fluoride manufacturer's color samples for final selection by Architect. After initial selection of colors by Architect from manufacturer's color charts, submit Architect's preliminary color choices on actual samples of metal substrate for final color selections by Architect.
      e. Samples will be reviewed by Architect for color and texture only. Compliance with other requirements is the responsibility of Contractor.
   2. Product Data:
      a. Copies of manufacturer's specifications, installation instructions and general recommendations for sheet metal flashing and trim required. Include manufacturer's data substantiating that the materials comply with the requirements.
      b. Submit full selection of manufacturer's standard, custom and premium color charts.
   3. Shop Drawings:
      a. Drawings showing the manner of forming, jointing and securing flashings and trim. Show fully dimensioned joint details and waterproof connections to adjoining Work and details at obstructions and penetrations.
      b. Drawings showing the coordination of the Work of this Section with Section 04201, Unit Masonry Construction, and Section 07555, PVC Roofing. Provide detailed Shop Drawings showing large scale details of sections and profiles of all sheet metal flashing and trim to be used in the Work, with all items, including fastener locations, cleats and other miscellaneous accessories necessary to complete the Work, fully dimensioned, properly located, quantified and presented such that sequence of installation is acceptable to each roofing system and adjacent construction material installer.

B. Informational Submittals: Submit the following:
   1. Qualifications Statements:
      a. Installer's qualifications

C. Closeout Submittals: Submit the following:
    1. Guarantee:
        a. Submit guarantee as specified herein.
    2. Warranty
        a. Submit warranty as specified herein.

1.05 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
    1. Deliver sheet metal flashing and trim materials in manufacturer's original, unopened, and undamaged containers and rolls, with labels intact and legible, indicating compliance with approved Shop Drawings.
    2. Items delivered in broken, damaged, rusted, or unlabeled condition shall immediately be removed from Site and not offered again for approval by Architect.

B. Storage of Materials:
    1. Store materials in an area undercover and protected from construction traffic.
    2. Store materials in same package in which they were shipped, off the ground and on platforms protected from dirt and other contamination.
    3. Store in a manner which does not permit water to remain on sheet metal flashing and trim materials and system components. Provide continuous protection of materials against wetting and contamination.

C. Handling of Materials:
    1. Protect sheet metal flashing and trim from dents, scratches, warps and bends.
    2. Remove strippable protective film, immediately proceeding installation of each system component.

1.06 JOB CONDITIONS

A. Scheduling:
    1. Do not proceed with sheet metal flashing and trim Work until curb and substrate construction, cant strips, blocking, reglets and other construction to receive the Work is completed.
    2. Deliver materials to the Site in sufficient quantities to ensure uninterrupted progress of the Work.
    3. Schedule the installation of sheet metal flashing and trim to coincide with the installation of built-up bituminous roofing, waterproofing, drains, piping, blocking, nailers, reglets, framing at openings, curbs, parapets and other adjoining and substrate Work.
    4. Proceed with and complete the Work only when materials, equipment and knowledgeable tradesmen, required for the installation of sheet metal flashing and trim, are at the Site and are ready to follow, and integrate sheet metal flashing and trim Work with roofing Work, in order to maintain watertight conditions.

1.07 GUARANTEE

A. Provide coping and cap flashing manufacturer's fifteen year warranty against blow-off, leak, or premature membrane failure in winds of up to 130 miles per hour.

B. Provide manufacturer's twenty-year warranty on the specified coil coated polyvinylidene fluoride based coating.

C. Guarantee that the polyvinylidene fluoride based coating meets all criteria specified and will not spall, check, craze, peel or otherwise lose adhesion for a period of twenty years from the date of installation, to the extent that such shall create unsightly conditions or otherwise impair the intended architectural qualities of the building.

D. In the event that the coil coated polyvinylidene fluoride based coating fails to meet the specified standards the manufacturer shall, at their own expense, replace or field paint, at the discretion of Owner, all areas affected by the failure. In the event that repainting is selected, it shall be done at mutually agreeable intervals throughout the term of the warranty.

E. The warranty specified shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

F. The warranty does not apply where failure is caused by accidents, or external conditions or forces beyond the control of the manufacturer.

PART 2 - PRODUCTS

2.01 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. Sheet metal flashing and trim shall be permanently watertight, and not deteriorate in excess of manufacturer's published limitations.
   2. Snap-lock coping shall be detailed, fabricated and installed to provide a minimum of FM 1-90 wind up-lift resistance and require no exposed fasteners of any kind.
   3. Comply with fabrication details recommended by FM, SMACNA, NRCA and the requirements of the sheet metal flashing and trim manufacturer, and as shown on approved Shop Drawings.

2.02 MATERIALS

A. Metal Sheet metal flashing and trim:
   1. Stainless Steel Sheet metal flashing and trim: Provide 26 gage sheet stainless steel, Type 316, complying with ASTM A 666, with No. 2D dead soft, fully annealed finish, unless required to be harder temper for proper forming and performance for application indicated.

2. Scupper Sleeve: One-piece slipover flashing for 4” diam. scupper pipe with presoldered flange in 26 gauge stainless steel.
    a. Product and Manufacturer: Provide one of the following:
        1) Model PL/S by SBC Industries.
        2) S-PDSR Series by Thunderbird Products.
        3) Or Equal.

B. Through-Wall and Waterproof Coursing:
1. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
    a. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
    b. Fabricate through-wall metal flashing embedded in masonry from 26 gage, Type 316 stainless steel, fabricated to provide an integral mortar bond.
    c. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
    d. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
    e. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
    f. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.

C. Formed Metal Coping, Caps and Trim: Provide smooth sheet of 16-gage, 5005-H134 aluminum alloy, complying with the following:
1. Provide coping and cap flashings, sized as shown, that provides for independent mounting and full expansion and contraction over prefabricated 6-inch wide aluminum retainers, compression clips mounted 12 feet - 0 inches on centers, and 2-inch wide aluminum retainer plates with single compression pad mounted between dual compression clips.
2. Provide system that incorporates a gutter bar with dual compression gaskets at each joint to drain water.
3. System shall not incorporate exposed sealants.
4. Provide internal face line-up splices at all joints.
5. All coping and cap flashings shall have all corners mitered and continuously heliarc welded watertight prior to shop-painting. Exposed mechanical fasteners, blind rivets and similar methods are not approved for the Work. Reinforce metal at welds as may be required to provide welded seams.
6. Concealed fasteners splice plates and neoprene compression pads shall be as recommended by the manufacturer.
7. Products and Manufacturers: Provide one of the following:
    a. Gutter Splice System TITE-LOC Coping by Peterson Aluminum Corporation.

b. Permasnap Coping by A.W.P. Hickman Company.
c. Or equal.

D. Elastic Sheet Flashing:
1. Polychloroprene synthetic rubber sheet, 1/16-inch thick, black, with the following physical properties:
a. Hardness, ASTM D 2240: 50 to 70 Shore A.
b. Tensile Strength, ASTM D 412: 1500 psi.
c. Tear Strength, ASTM D 624: 120 pounds per linear inch.
d. Elongation, ASTM D 412: 300 percent.
e. Brittleness Temperature, ASTM D 746: -30°F.
2. Butyl synthetic rubber sheet, 1/16-inch thick, black, with the following physical properties:
a. Hardness, ASTM D 2240: 50 to 70, Shore A.
b. Tensile Strength, ASTM D 412: 1200 psi.
c. Tear Strength, ASTM D 624: 200 pounds per linear inch.
d. Elongation, ASTM D 412: 300 percent.
e. Brittleness Temperature, ASTM D 746: -30°F.
3. Ethylene-propylene-diene monomer synthetic rubber sheet, 1/16-inch thick, black, with the following physical properties:
a. Hardness, ASTM D 2240: 50 to 70, Shore A.
b. Tensile Strength, ASTM D 412: 1400 psi.
c. Tear Strength, ASTM D 624: 125 pounds per linear inch.
d. Elongation, ASTM D 412: 300 percent.
e. Brittleness Temperature, ASTM D 746: -75°F.

E. Flashing Reglets:
1. General:
a. Provide snap-lock type reglets of Type 304 stainless steel, 0.020-inches minimum thickness.
b. Provide reglets that engage counterflashing by use of a snap-lock or spring-lock profile. System shall employ only mechanical interlocking features for securing counterflashing in reglet, without the need for clips or screws.
c. Provide manufacturer's standard Type 304 stainless steel spring-lock profile flashing, 5-1/8-inches high, designed to incorporate a positive air break and to engage spring-lock reglet flange.
d. Provide reglets with 1-inch end laps and spring-lock flashing with 3-inch end laps.
2. Cast-In-Place Reglets: Provide, cast-in-place reglets for concrete, with manufacturer's standard foam backer rod to prevent cement from entering reglet.
a. Provide reglet with a vertical snap-lock engagement slot, 1-inch high by 1/2-inch deep with connector alignment clips and special staples for securing to formwork.
b. Products and Manufacturers: Provide one of the following:

1) Type CO Concrete Reglet by Fry Reglet Corporation.
2) Type CF Concrete Reglet with type 2 flashing by O"Keeffe's Architectural Building Products.
3) Or equal.

3. Surface-Mounted Reglets: Provide reglets for surface mounting, with slots for expansion, and a complete line of manufacturer's standard accessories including drive pins, and 7/8-inch diameter stainless steel washers with neoprene facing.
   a. Provide engagement flange 2-1/2-inch high by 1/2-inch wide with snap-lock profile shaped to receive sealant at top lip edge and at mid-flange recess.
   b. Products and Manufacturers: Provide one of the following:
      1) Type SM Surface Mounted Reglet by Fry Reglet Corporation.
      2) Type EN Surface Mounted Reglet by O"Keeffe's Architectural Building Products.
      3) Or equal.

F. Drip Trays:
   1. General: Provide drip trays to contain condensation, leaks, and other fluid discharge from equipment and pipe as indicated on the drawings.
   2. Materials: Seamless type 304, 20-gauge minimum stainless steel.
   3. Size: Provide in lengths and widths as required to provide protection under equipment and below piping above equipment as indicated on the drawings.
   4. Construction: Welded water tight construction with 2-1/2 inch raised edges all around to contain liquid.
   5. Support: Provide light gauge metal framing secured to building structure to support drip trays where indicated on contract drawings.
   6. Finish: No. 4 stainless steel finish.

G. Miscellaneous Materials:
   1. Solder for Stainless Steel: ASTM B32, 96 percent tin and 4 percent silver, used with an acid flux of the type recommended by the stainless steel manufacturer. Use a non-corrosive rosin flux over tinned surfaces.
   2. Stainless Welding Rods: Type recommended by stainless steel sheet manufacturer for the type of metal sheets furnished.
   3. Nails, Screws and Rivets: Same material as flashing sheet, or as recommended by manufacturer of flashing sheet.
   4. Cleats: Same metal and gage as sheet being anchored, 2-inches wide, punched for two anchors.
   5. Bituminous Coating: Refer to Section 07111, Bituminous Dampproofing.
   6. Sealants: Refer to Section 07920, Joint Sealants.
   7. Roofing Cement: Provide a medium to heavy trowel-grade, cut-back asphalt mastic roof cement reinforced with non-asbestos fibers, and containing petroleum solvents and special mineral stabilizers, complying with ASTM D 4586, Type II.
   8. Base Flashing Felts: Asphalt-coated, polyester/glass scrim reinforced flashing sheet or as recommended by the manufacturer of the built-up bituminous roofing.

2.03 FABRICATION

2.04 ALUMINUM COPINGS, GRAVEL STOPS AND CAP FLASHING FINISHES

A. Exposed Aluminum Polyvinylidene Fluoride Based Coating: Apply full strength polyvinylidene fluoride based coatings at the factory by coil coating for sheet material and spray coating for extruded or factory-fabricated material. Provide the following four coat finish system complying with the following:
   1. Alkali clean and hot water rinse all surfaces to receive polyvinylidene fluoride based finish.
   2. Prepare a chemical conversion coating on the surface, using phosphates or chromates followed by a cold water rinse. Seal with a chromic acid rinse and dry, except where manufacturer recommends another method to achieve greater coating reliability.
   3. Apply a base prime coat of epoxy paint to the prepared surface in its coil form, by reverse roller coating. Fully cure in a gas-fired oven to a dry film thickness of 0.2 to 0.4-mils. Follow with a barrier coat, 1.0-mils thick.
   4. Apply color coat containing mica pearlescent or metallic flakes over the barrier coat by roller coating for coil material and airless or Ransburg Elastrostatic Hand Spray for extrusions and fuse at a peak metal temperature of 440°F for a dry film thickness of 0.7-mils for coil coating and 1.2-mils for spray coating so that the total dry film is approximately 1.0-mil thick for coil material and 1.5-mils thick for extruded material.
   5. Apply clear fluoropolymer top coat to provide a dry film thickness of 0.4 to 0.8-mils. The entire four coat system shall have a dry film thickness of 2.6-mils, minimum.
   6. Provide the following physical properties, as proven by appropriate and recognized laboratory test methods acceptable to Architect:
      a. Weathering, ASTM D 4214: Chalking, not more than No. 8, after exposure for 5000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      b. Color Change, ASTM D 2244: No greater than 5 NBS units after removal of external deposits and after exposure for 5000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      c. Humidity Resistance, ASTM D 2247; no blisters after 3000 hours.
      d. Salt Spray, ASTM B 117: Few scattered blisters no larger than ASTM No. 4, and no more than 1/16-inch creep from areas scribed to bare metal after 3000 hours.
      e. Dry Adhesion: No pick-off when tape tested over 1/16-inch cross hatch.
      f. Wet Adhesion: No pick-off when tape tested over 1/16-inch cross hatch; extruded material only.
      g. Boiling Water Adhesion: No pick-off when tape tested over cross hatch area after one hour immersion in distilled boiling water.
      h. Water Immersion: No pick-off when tape tested over cross hatch area after immersion in aerated distilled water 80 ±10°F after 500 hours.
      i. Abrasion Resistance, ASTM D 968: Coefficient of abrasion of 67, minimum.

j. Gloss, ASTM D 523: 30±5 reflectivity at 60°F.
k. Pencil Hardness, ASTM D 3363: HB-H minimum.
l. Dry Film Thickness, ASTM D 3363: Primer, 0.2 to 0.4-mils; barrier coat, 1.0-mils; color coating, 0.7 to 1.5-mils; clear topcoat, 0.4 to 0.8-mils.
m. Solvent Resistance: 100 Double MEK rubs minimum.
n. Flexibility, ASTM D 522: No cracking prior to metal fracture.
o. Acid Resistance, ASTM D 1308: 16 hour spot test with five percent hydrochloric acid - no effect.
p. Alkali Resistance, ASTM D 1308: 16 hour spot test with five percent sodium hydroxide - no effect.

B. Colors: Provide the following:
1. Full selection of manufacturer's standard, custom and premium colors for final selection by Architect.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor and installer shall examine the substrate and the conditions under which the sheet metal flashing and trim Work is to be performed, and notify Architect, in writing, of unsatisfactory conditions. Do not proceed with sheet metal flashing and trim Work until unsatisfactory conditions have been corrected in a manner acceptable to Architect.

3.02 PREPARATION

A. Before installing sheet metal flashing and trim, verify shapes, and dimensions to be covered.

B. Prepare substrates as recommended by the sheet metal manufacturer.

C. Clean the substrate of dust, debris, substances and interferences detrimental to the Work and prepare substrates as recommended by the sheet metal manufacturer.

3.03 INSTALLATION

A. General:
1. Separate dissimilar metals from each other by painting each metal surface in the area of contact with a heavy application of bituminous coating, or by other permanent separation as recommended by the manufacturers of the dissimilar metals. Comply with the following:
a. Separate stainless steel from dissimilar metals, including regular steel and iron, and from cementitious materials by a course of roofing felt wherever possible. Where felt application is not possible, coat the stainless steel or the other material with a 15-mil bituminous coating. Where felt is applied under sheets which will be soldered or welded, cover felt with a course of building paper before installing stainless steel. Comply with manufacturer's

recommendations for other forms of protection of the stainless steel against corrosion.

2. Fabricate and install Work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves and avoidable tool marks, considering the temper and reflectivity of the metal. Provide uniform, neat flat-locked seams with minimum exposure of solder, welds and sealant. Except as otherwise shown, fold back the sheet metal to form a hem on the concealed side of exposed edges. All exposed edges of all sheet metal flashing shall be hemmed not less than 1/2-inch wide.
3. Conceal fasteners and expansion provisions wherever possible in exposed Work, and locate so as to minimize the possibility of leakage. Cover and seal Work as required for a watertight installation.
    a. Provide cleat-type anchorages for metal flashings and trim wherever practical, arranged to relieve stresses from building movement, and thermal expansion and contraction.
    b. Provide thermal expansion for running trim, flashing and other items exposed for more than 15 feet - 0 inch continuous length. Maintain a watertight installation at expansion seams. Locate expansion seams at 15 feet - 0 inch intervals, and 2 feet - 0 inch each side of corners and intersections.
4. On vertical surfaces lap two-piece flashings a minimum of 4-inches.
5. On sloping surfaces, for slopes of not less than 6-inches in 12-inches, lap unsealed flashings a minimum of 6-inches. For slopes less than 6-inches in 12-inches use soldered flat locked seams.
6. For embedment of metal flashing flanges in built-up bituminous roofing or composition flashing or stripping, extend flanges for a minimum of 4-inches embedment.

B. Installation of Stainless Steel Sheet metal flashing and trim:
    1. Tin the edges of plain stainless steel to be soldered, for a width of 1-1/2-inches, using solder for stainless steel and acid flux. Remove every trace of acid flux residue from the metal promptly after tinning or soldering.
    2. Where welded joints are shown, provide upturned, 1/2-inch wide hooked flanges, and weld between adjoining sheets; lay seam flat.

C. Installation of Through Wall and Waterproof Course Flashing:
    1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
    2. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they

cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Installation of Metal Copings and Fascia Sections:
   1. Install metal copings using concealed fasteners and plates in compliance with manufacturer's written recommendations as shown on approved Shop Drawings.
   2. Coping and cap flashings shall be installed with 3/8-inch wide butt joints 12 feet-0 inches on center, unless otherwise shown.
   3. Use all items supplied by the manufacturer for a complete, watertight and blow-off resistant installation.
   4. Set all flashings straight, level and plumb.

E. Installation of Elastic Sheet metal flashing and trim:
   1. Bond elastic sheet metal flashing and trim sheets to vertical substrates and to other surfaces as indicated or recommended by sheet manufacturer, and seam the end joints.
   2. On bituminous membranes provide not less than 4-inches of mechanically fastened cover over built-up composition base flashings.

F. Installation of Reglets and Reglet Counterflashing:
   1. For installation of cast-in-place reglets refer to Section 03300, Cast-In-Place Concrete.
   2. For installation of built-in-place masonry reglets refer to Section 04201, Unit Masonry Construction.
   3. Install surface-mounted reglets complying with manufacturer's written instructions to produce a watertight installation. Use sealant specified in Section 07920, Joint Sealants.
   4. Install counterflashing with positive pressure against base flashing and reglet and with air break at mid-point to prevent capillary action. No screws or exposed fasteners shall be permitted in the finished Work except those required at each pre-punched hole for surface-mounted reglet attachment.
   5. End lap counterflashing horizontally a minimum of 3-inches.
   6. Overlap built-up composition base flashing with counterflashing a minimum of 4-inches vertically and fold lower edge back on itself for 1/2-inch.

3.04 FIELD QUALITY CONTROL

A. Polyvinylidene Fluoride Based Coatings: Determine conformity of sheet metal flashing and trim Work requiring painted finish to these Specifications as follows:
   1. The manufacturer of the sheet metal flashing and trim Work shall set aside and label samples of each component of the sheet metal flashing and trim Work from each production lot for the Project. Protect samples from weather.
   2. Make samples of sheet metal flashing and trim Work available at all times, for comparison with installed sheet metal flashing and trim Work as requested by Owner, for the full time of the warranty.

3. Make color comparison measurements with a Hunter Tristimulus Color Difference Meter employing methods of computation in use at the National Bureau of Standards conforming to ASTM D 2224.

3.05 ADJUSTMENT AND CLEANING

A. Protect sheet metal flashing and trim until Final Acceptance of the Work.

B. Do not permit workmen, or others, to step directly on flashing sheets in place, or to place or move equipment over sheet metal flashing and trim surfaces. Protect surfaces during installation of permanent covering work and adjoining Work.

C. Neutralize excess flux as the Work progresses with five percent to percent washing soda solution and rinse thoroughly.

D. Clean exposed surfaces of every substance which is visible or might cause corrosion or prevent uniform oxidation of the metal surfaces. Exercise extreme care to remove fluxes and ferrous metal particles, including welding splatter and grinding dust.

+ + END OF SECTION + +

SECTION 07710

ROOF SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all roof specialties Work.
   2. The extent of the roof specialties is shown.
   3. The types of roof specialties Work required includes, but is not necessarily limited to, the following:
      a. Exposed surface-mounted scuppers, conductor heads and downspouts to match insulated metal wall panels.
      b. All miscellaneous straps, fittings and fasteners.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that shall be installed with the roof specialties Work.

1.02 STANDARDS REFERENCED IN THIS SECTION ARE LISTED BELOW:

A. Federal Specification, (FS).
   1. FS H-C-494, Coating Compound, Bituminous, Solvent Type, Acid Resistant.

1.03 QUALITY ASSURANCE

A. Design Criteria:
   1. Standards: Comply with applicable standards and recommendations of SMACNA, Architectural Sheet Metal Manual, for the fabrication and installation of roof specialties Work, except to the extent more stringent requirements are specified.

B. Component Supply and Compatibility: Provide roof drains, drainage sumps, and downspouts as a complete unit produced by a single manufacturer specializing in the production of this type of Work, including hardware, accessories, mounting and installation components.

1.04 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Shop Drawings:
      a. Shop Drawings showing the manner of forming, jointing and securing the metal to form roof specialties Work. Show expansion joint details and

water-proof connections to adjoining work and at obstructions and penetrations.

2. Product Data:
   a. Copies of manufacturer's specifications, recommendations and installation instructions for roof specialties applications. Include manufacturer's certification or other data substantiating that the materials comply with the requirements.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials to preclude denting, scratching or otherwise marring the surface and finish of the roof specialties material.

1.06 JOB CONDITIONS

A. Scheduling: Coordinate roof specialties Work with roofing, flashing, trim, and the construction of decks, parapets and other adjoining work, to provide a permanently watertight, leak-proof, secure and non-corrosive installation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide stainless steel sheet, Type 316, with smooth finish to match metal wall panels; downspout thickness 20-gauge; conductor head thickness of 20-gauge minimum; scupper of 20-gauge minimum.

B. Size and Profile:
   1. Downspouts: 6-inch square or as shown on drawings.
   2. Drainage Sump: Size as required for proper transition and drainage.

C. Miscellaneous Materials:
   1. Provide the materials and types of fasteners, solder, welding rods, coatings, separators, wall penetration, sealants, and accessory items as recommended by the sheet metal manufacturer for roof specialties Work, except as otherwise shown.
   2. Cleats and Straps: Same metal as roof specialties Work being anchored or supported.
   3. Roofing Cement: Neoprene adhesive, compatible with substrate and adjoining work.
   4. Bituminous Coating: Cold-applied asphaltic coating, FS TT-C-494, Type II, compounded for minimum thickness per coat of 15-mils (dry).

D. Products and Manufacturers: Provide one of the following:
   1. Conductor Head, Through Wall Scupper and Downspouts by W.P. Hickman Construction Products.
   2. Conductor Head, Through Wall Scupper and Downspouts by Viking metal Products.

3. Conductor Head, Through Wall Scupper and Downspouts by Metal-Era.
4. Or equal.

2.02 FABRICATION

A. General:
   1. The fabrication requirements for metal drainage sumps and downspout Work apply to both shop-fabricated and on-site fabricated Work.
   2. Manufacturer's Recommendations: Except as otherwise shown or specified, comply with the recommendations and instructions of the manufacturer of the sheet metal being fabricated.
   3. Provide for thermal expansion of exposed items. Maintain a water-tight seal at expansion joints. Locate expansion joints at the following maximum spacings:
      a. Midpoint of run.
   4. Fabricate Work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves and avoidable tool marks, considering the temper and reflectivity of the metal. Provide uniform, neat seams with minimum exposure of solder, welds and sealant. Fold back the sheet metal to form a hem on the concealed side of exposed edges.
   5. Fabricate drainage sumps and downspouts and supports as shown .
   6. Support and Anchorage: Fabricate units with adequate provisions for support and anchorage, of the types required for the indicated method of installation.

B. Drainage Sump and Downspouts: Fabricate stainless sheet using double flat-lock seams. Rivet joints where necessary for strength. Pop rivets are not acceptable.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor and installer shall examine the supporting structure and other elements of the substrate and conditions under which the roof specialties Work is to be performed and notify Engineer, in writing, of any conditions detrimental to the proper and timely completion of the Work and performance of the drainage sumps, roof and overflow drains, and downspouts. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.02 PREPARATION

A. Wherever possible, take field measurements, prior to completion of shop fabrication and finishing of metal drainage sumps and downspout Work. Do not delay job progress. Allow for erection tolerances corresponding with specified tolerances where final dimensions cannot be established before fabrication.

3.03 INSTALLATION

A. Comply with manufacturer's recommendations and installation instructions.

B. Protection of Stainless Steel from Dissimilar Materials: Coat all stainless steel surfaces in contact with dissimilar materials such as concrete, masonry, steel and other metals as specified in Section 09900, Painting.

C. Conceal fasteners and expansion provisions, wherever possible, in exposed Work, and locate so as to minimize the possibility of leakage. Cover and seal Work, as required, for a tight installation.

D. Provide concealed cleat-type anchorages wherever practical and arrange to relieve stresses in the roof specialties Work which result from building movement and thermal expansion.

E. Splice and Expansion Units: Use 0.050-inch thick splice plates.

F. Bed flashing flanges in a bed of roofing cement or other setting compound which is compatible with adjoining work and substrate.

G. On vertical overlaps, lap sheet metal a minimum of 3-inches.

H. On sloping overlaps, of slopes of not less than 6-inches in 12-inches, lap unsealed overlaps a minimum of 6-inches.

I. For embedment of metal flanges in elastic sheet flashing or stripping, extend flanges for a minimum of 4-inches embedment.

J. Support and anchor each unit of Work in the manner as shown, but in no case in a manner which would be inadequate for thermal expansion stresses and the normal loading of water, wind and similar loadings.

K. Install units with lines and corners true and accurate in alignment and location. Install drainage sumps to assure positive drainage to downspouts.

3.04 CLEANING AND PROTECTION

A. Protect the roof drains, metal drainage sumps, and downspouts from all damage until Final Completion.

B. Roof drains, drainage sumps and downspouts damaged before Final Completion shall be replaced with new material as specified herein, at no additional cost to Owner.

C. Clean exposed surfaces of every substance which is visible or might cause corrosion of the metal or deterioration of the finish.

+ + END OF SECTION + +

SECTION 07812

INTUMESCENT FIREPROOFING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes mastic and intumescent fire-resistive coatings (MIFRC).

B. Provide intumescent fireproofing where indicated on the drawings. At a minimum provide on all exposed steel columns, cross bracing, girders, beams, and secondary support members unless other fire protection is indicated. Refer to code plans for fire ratings.

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review products, design ratings, restrained and unrestrained conditions, thicknesses, and other performance requirements.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, 4 inches (102 mm) square in size.

C. Shop Drawings: Framing plans, schedules, or both, indicating the following:
   1. Extent of fire protection for each construction and fire-resistance rating.
   2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
   3. Minimum fire protection thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
   4. Treatment of fire protection after application.
   5. Coordinate with Applied Fire Protection shop drawings.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Product Certificates: For each type of fireproofing.

C. UL Design Assembly number including selected products as indicated on the drawings.

D. Evaluation Reports: For fireproofing, from ICC-ES.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

1.07 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 50 deg F (10 deg C) or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fireproofing for each fire-resistance design from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E119 or UL 263 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction
   1. Flat Paints and Coatings: 50 g/L.

E. Non-flat Paints and Coatings: 150 g/L.
   1. Primers, Sealers, and Under-coaters: 200 g/L.

F. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
   1. Fireproofing Exterior Coatings: 350 g/L.
   2. Asbestos: Provide products containing no detectable asbestos.

2.02 MASTIC AND INTUMESCENT FIRE-RESISTIVE COATINGS

A. MIFRC: Manufacturer's standard, factory-mixed formulation or factory-mixed, multicomponent system consisting of intumescent primer, base coat and topcoat, and complying with indicated fire-resistance design.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Albi Manufacturing, Division of StanChem Inc.; Albi Clad 800 for interior or exterior applications.
      b. Carboline Company, subsidiary of RPM International, Fireproofing Products Div.; Thermo-Lag 3000-SP for interior or exterior applications.
      c. Isolatek International; Cafco Spray Film-WB 5 for internal applications, Cafco Spray Film-WB 4 for exterior applications.
   2. Application: Designated for "exterior" "interior general purpose" use by a qualified testing agency acceptable to authorities having jurisdiction.
   3. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design.
   4. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 15 or less.
      b. Smoke-Developed Index: 50 or less.
   5. Hardness: Not less than 80, Type D durometer, according to ASTM D2240.
   6. Finish color: As selected by Architect from manufacturer's standard finishes.
      a. Texture and Gloss: As indicated by manufacturer's designations for items concealed by construction. Smooth and Gloss for items left exposed.

2.03 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Prime galvanized steel with fast cure high solids polyamide epoxy mastic as approved by the intumescent coating manufacturer for the intended use. Basis-of-Design: Macropoxy 646 as manufactured by Sherwin Williams, or approved equal.

C. Topcoat: Suitable for application over applied fireproofing; of type recommended in writing by fireproofing manufacturer for each fire-resistance design.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design. Verify compliance with the following:
   1. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.
   2. Objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
   3. Substrates receiving fireproofing are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fireproofing application.

B. Conduct tests according to fireproofing manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application.

B. Clean substrates of substances that could impair bond of fireproofing.

C. Prime substrates where included in fire-resistance design and where recommended in writing by fireproofing manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fireproofing.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

E. Coordinate application with construction schedule to coat and allow curing of items requiring Intumescent coating prior to installation(s).

3.03 APPLICATION

A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness,

primers, topcoats, finishing, and other materials and procedures affecting fireproofing work.

B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.
   1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
   2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.

D. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written recommendations for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.

E. Spray apply fireproofing to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.

F. Extend fireproofing in full thickness over entire area of each substrate to be protected.

G. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.

H. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.

I. Cure fireproofing according to fireproofing manufacturer's written recommendations.

J. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.

K. Finishes: Where indicated, apply fireproofing to produce the following finishes:
   1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.

3.04 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Test and inspect as required by the NYSBC 1705.14.

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Fireproofing will be considered defective if it does not pass tests and inspections.
   1. Remove and replace fireproofing that does not pass tests and inspections, and retest.
   2. Apply additional fireproofing, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

3.05 CLEANING, PROTECTING, AND REPAIRING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing will be without damage or deterioration at time of Substantial Completion.

C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.

D. Repair fireproofing damaged by other work before concealing it with other construction.

E. Repair fireproofing by reapplying it using same method as original installation or using manufacturers recommended trowel-applied product.

+ + END OF SECTION + +

SECTION 07840

APPLIED FIRE PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes sprayed fire-resistive materials (SFRM).

B. Applied fire protection is intended to provide the required fire rating to structural steel members, as indicated on code plans, where concealed from view.

1.03 PRE-INSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Framing plans, schedules, or both, indicating the following:
   1. Extent of fire protection for each construction and fire-resistance rating.
   2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
   3. Minimum fire protection thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
   4. Treatment of fire protection after application.
   5. Coordinate with Intumescent Fireproofing shop drawings.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Product Certificates: For each type of fire protection.

C. Evaluation Reports: For fire protection, from ICC-ES.

D. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fire protection manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

B. Mockups: Build mockups.
   1. Build mockup of each type of fire protection and different substrate as shown on Drawings.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: a qualified testing agency to perform preconstruction testing on fire protection.
   1. Provide test specimens and assemblies representative of proposed materials and construction.

B. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.
   1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E736/E736M. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   2. Density: Test for density according to ASTM E605/E605M. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with fire protection.
   4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   5. For materials failing tests, obtain applied-fire protection manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.08 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fire protection when ambient or substrate temperature is 40 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

1.09 COORDINATION

A. Sequence and coordinate application of SFRM with other related work specified in other Sections to comply with the following requirements:
   1. Provide temporary enclosure as required to confine spraying operations and protect the environment.
   2. Provide temporary enclosures for applications to prevent deterioration of fire-resistive material due to exposure to weather and to unfavorable ambient conditions for humidity, temperature, and ventilation.
   3. Avoid unnecessary exposure of fire-resistive material to abrasion and other damage likely to occur during construction operations subsequent to its application.
   4. Do not apply fire-resistive material to metal roof deck substrates until concrete topping, if any, has been completed. For metal roof decks without concrete topping, do not apply fire-resistive material to metal roof deck substrates until roofing has been completed; prohibit roof traffic during application and drying of fire-resistive material.
   5. Do not apply fire-resistive material to metal floor deck substrates until concrete topping has been completed.
   6. Defer installing ducts, piping, and other items that would interfere with applying fire-resistive material until application of fire protection is completed.
   7. Do not install enclosing or concealing construction until after fire-resistive material has been applied, inspected, and tested and corrections have been made to defective applications.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Assemblies: Provide fire protection, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fire protection from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E119 or UL 263 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction.

E. Low-Emitting Materials: Fire protection used within the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Asbestos: Provide products containing no detectable asbestos.

2.02 SPRAYED FIRE-RESISTIVE MATERIALS

A. SFRM : Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Grace, W. R. & Co. - Conn.; Grace Construction Products; Monokote Z106 & Monokote Z106/HY.
      b. Isolatek International; Cafco Blaze-Shield HP.
      c. Architect/Engineer approved equivalent.
   2. Bond Strength: Minimum 2,000 lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E736/E736M.
   3. Density: Not less than 22 lb/cu. ft. and as specified in the approved fire-resistance design, according to ASTM E605/E605M.
   4. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E605/E605M, whichever is thicker, but not less than 0.375 inch.
   5. Combustion Characteristics: ASTM E136 shall be non-combustible.
   6. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 0.
      b. Smoke-Developed Index: 0.
   7. Compressive Strength: Material shall not deform more than 10 percent when subjected to a crushing force of 100 psi when tested in accordance with ASTM E761/E761M.
   8. Corrosion Resistance: No evidence of corrosion according to ASTM E937/E937M .
   9. Deflection: No cracking, spalling, or delamination according to ASTM E759/E759M.
   10. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E760/E760M.
   11. Air Erosion: Maximum weight loss of 0.000 g/sq. ft. (0.270 g/sq. m) in 24 hours according to ASTM E859/E859M.

12. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G21.
13. Finish: As selected by Architect from manufacturer's standard finishes Spray-textured finish.
14. Color: Grey

2.03 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that are compatible with fire protection and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by fire protection manufacturer and complying with one or both of the following requirements:
1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Fire protection manufacturer shall be contacted for procedures on handling primed / painted steel.
3. Primer's bond strength in required fire-resistance design complies with specified bond strength for fire protection and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E736/E736M.

C. Bonding Agent: Product approved by fire protection manufacturer and complying with requirements in the UL "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.

D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, according to fire-resistance designs indicated and fire protection manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive fire protection.

E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by fire protection manufacturer.

F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by fire protection manufacturer. Include pins and attachment.

G. Sealer: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by fire protection manufacturer for each fire-resistance design.
1. Product: Subject to compliance with requirements, provide "Cafco Bond-Seal or Cafco Bond-Seal Type X" by Isolatek International.

H. Topcoat: Suitable for application over applied fire protection; of type recommended in writing by fire protection manufacturer for each fire-resistance design.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design. Verify compliance with the following:
   1. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.
   2. Objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
   3. Substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.

B. Verify that roof construction, installation of roof-top HVAC equipment, and other related work is complete before beginning fire protection work.

C. Conduct tests according to fire protection manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fire protection materials during application.

B. Post signage "Slippery When Wet" and erect appropriate barriers to alert on-site personnel / workers of slippery conditions in the area(s) of Spray fire protection applications.

C. Clean substrates of substances that could impair bond of fire protection.

D. Prime substrates where included in fire-resistance design and where recommended in writing by fire protection manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.

E. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface

of fire protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.03 APPLICATION

A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fire protection work.

B. Comply with fire protection manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.
   1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
   2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.

D. Metal Decks:
   1. Do not apply fire protection to underside of metal deck substrates until concrete topping, if any, has been completed.
   2. Do not apply fire protection to underside of metal roof deck until roofing has been completed; prohibit roof traffic during application and drying of fire protection.
   3. When roof traffic is anticipated, as in the case of periodic maintenance, roofing pavers shall be installed as a walkway to distribute the loads.

E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fire protection manufacturer's written recommendations for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fire protection manufacturer.

F. Spray apply fire protection to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fire protection manufacturer.

G. Extend fire protection in full thickness over entire area of each substrate to be protected.

H. Install body of fire protection in a single course unless otherwise recommended in writing by fire protection manufacturer.

I. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fire protection that differs in color from that of encapsulant over which it is applied.

J. Where sealers are used, apply products that are tinted to differentiate them from fire protection over which they are applied.

K. Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.

L. Cure fire protection according to fire protection manufacturer's written recommendations.

M. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.

N. Finishes: Where indicated, apply fire protection to produce the following finishes:
   1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.
   2. Spray-Textured Finish: Finish left as spray applied with no further treatment.

3.04 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Test and inspect as required by the NYSBC 1705.14.
   2. For reference, utilize AWCI - Inspection Procedure for Field-Applied Sprayed Fire Resistive Materials, Technical Manual 12-A; an annotated guide.

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Fire protection will be considered defective if it does not pass tests and inspections.
   1. Remove and replace fire protection that does not pass tests and inspections, and retest.
   2. Apply additional fire protection, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

3.05 CLEANING, PROTECTING, AND REPAIRING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

B. Remove all fire protection application equipment and residual supplies from the site upon completion of the work of this section.

C. Protect fire protection, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fire protection will be without damage or deterioration at time of Substantial Completion.

D. As installation of other construction proceeds, inspect fire protection and repair damaged areas and fire protection removed due to work of other trades.

E. Repair fire protection damaged by other work before concealing it with other construction.

F. Repair fire protection by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

+ + END OF SECTION + +

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SECTION 07841

FIRESTOPPING FOR THROUGH PENETRATIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Agreement, including General and Division 01 of the Project Manual, apply to work of this Section.

1.02 SUMMARY

A. This Section includes through-penetration Firestop systems for penetrations through fire-resistance-rated horizontal and vertical constructions, including both empty openings and openings containing penetrating items. Fire-rated joint construction in or between fire-resistance rated construction and at exterior curtain wall/floor intersections.

B. This Section includes fireblocking within the exterior cavity wall by use of vertical safing insulation (mineral wool insulation strips) compressed within the cavity at a specific spacing.

C. Related Sections include the following:
   1. Divisions 15 Sections specifying pipe and duct penetrations.
   2. Divisions 16 Sections specifying cable and conduit penetrations.

1.03 STANDARDS

A. All work of this section shall conform to industry standards and/or manufacturer's recommendations.

B. ASTM E814 "Standard Test Method of Fire Tests of Penetration Firestop Systems".

C. UL 1479 "Standard for Fire Tests of Penetration Firestops".

D. UL "Building Materials Directory".

1.04 SUBMITTALS

A. Submit pursuant to Section 01300 - Submittals.

B. Product Data:
   1. For each type of product necessary to complete all types of firestopping required on the project.
   2. Safing Insulation product data.
   3. Firestopping pillows.

C. Samples:
   1. Provide samples of any item requested by the Architect or AHJ.

D. Product Schedule: For each interior penetration firestopping system. Include location and design designation of qualified testing and inspection agency.
   1. Engineering Judgements: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system or joint firestopping system condition, submit illustration, with modifications marked, approved by firestopping system manufacturer's fire-protection engineer as an engineering judgement or equivalent equivalent fire-resistance rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

E. Qualification Data: For qualified installer.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing penetration fire stopping similar in material, design, and extent to that Indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
   1. Installer shall have a documented and archived record-keeping system for all installations.
   2. A different installer may install cavity wall fireblocking.

B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
   1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
      a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
      b. Classification markings on penetration firestopping correspond to designations listed by the following:
         1) FM Global in its "Building Materials Approval Guide".
         2) UL in its "Fire Resistance Directory".

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver through-penetration Firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels

identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspection agency's classification marking applicable to Project, curing time, and mixing instructions for multi-component materials.

B. Store and handle materials for through-penetration Firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

C. Comply with recommended procedures, precautions or remedies described in Material Safety Data Sheets (MSDS) as applicable.

D. Do not use damaged or expired materials.

1.07 REGULATORY REQUIREMENTS

A. Provide fire and smoke resistivity pursuant to New York State Building Code and NFPA.

1.08 PROJECT CONDITIONS

A. Environmental Limitations: Do not install interior through-penetration Firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration Firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration Firestop systems per manufacturer's written instructions by natural means or where this is inadequate, forced-air circulation.

1.09 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration Firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, and/or cut openings to accommodate penetration firestopping.

C. Do not cover up through-penetration Firestop system installations that will become concealed behind other construction until each installation has been examined by building inspector and/or authorities having jurisdiction, if required.

D. Coordinate installation of vertical safing insulation (mineral wool strips) in exterior wall cavity with completion of spray foam insulation and the start of veneer construction.

E. Contractor shall coordinate fire resistive joint systems provided by all trades to ensure compatibility between types.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Emerson Industrial Automation; Nelson Firestop Products.
   2. Grace Construction Products; W.R. Grace & Co. - Conn.
   3. Hilti, Inc.
   4. Tremco, Inc., Tremco Fire Protection Systems Group.
   5. USG Corporation.
   6. 3M Fire Protection Products.
   7. Owens Corning (Cavity Wall Fire Blocking).

2.02 FIRESTOPPING OF THROUGH PENETRATIONS AND VOIDS

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
   1. Fire-resistance-rated walls include fire walls, fire-barrier walls and fire partitions.
   2. F-Rating: Not less than the fire resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
   1. Horizontal assemblies include ceiling membranes of roof/ceiling assemblies.
   2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
   3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Designs: Firestopping designs tested pursuant to ASTM E814 or UL 1479, and UL "Classified" for the application intended.
   1. Through penetration firestops: UL category XHCR for devices; category XHEZ for systems.
   2. Fill void, and cavity firestopping: UL category XHHW for firestopping materials; category XHKU for forming materials; pursuant to UL Classified systems for openings other than through penetrations.

UL ASSEMBLIES FOR THROUGH WALL PENETRATIONS						
PENETRANTS						
WALL TYPE	METAL CONDUIT	CABLES	NON-INSUL. METAL PIPE	INSUL. PIPE	FR POLY PROPYLENE PIPE	INSULATED METAL DUCT
GWB Stud Wall or Shaft Wall up to 2-HR Rating	W-L-1001	W-L-3001	W-L-1001	W-L-5011	W-L-2002	W-L-7009 up to 24"x12" W-L-7025 up to 42"x28"
CMU Wall up to 2-HR Rating	C-AJ-1044 C-AJ-1008	C-AJ-3029 C-AJ-3030	C-AJ-1044	C-AJ-5001	C-AJ-2001	C-AJ-7003 C-AJ-7016
Concrete Floor up to 1-HR Rating	C-AJ-1091 C-AJ-8181 for conduit bank	C-AJ-3029	F-A-1105	C-AJ-5091	C-AJ-2271	C-AJ-7145
Note: Up to 1-hour rating, submit engineered judgment firestopping system for this combination of penetrant, wall/floor assembly and fire rating.						

E. Performance: F and T rating of not less than 1 hr.; with F rating to match fire resistance rating of assembly or barrier being penetrated.

F. Design selection: Based on performance and, when compared to other designs that may be suitable, based upon ability to provide environmental/water seal and accommodate:
   1. Movement transmitted by the penetration item.
   2. Thermal expansion of construction materials.
   3. Future modifications to utilities, services, and penetrations.

G. Fire-rated Caulk manufacturers:
   1. Approved intumescent sealant or putty.

H. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
   1. Permanent forming/damming/backing materials, including the following:
      a. Thermafiber® Safing Formaldehyde-Free mineral wool insulation.
      b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
      c. Fire-rated form board.
      d. Fillers for sealants.
   2. Temporary forming materials.
   3. Substrate primers.

4. Collars.
5. Steel sleeves.

2.03 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.
   1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor or roof in or between which it is installed.

C. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

D. Accessories: provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

2.04 FILL MATERIALS

A. Safing Mineral Wool: High Temperature Mineral Wool Insulation for concealed fill material.
   1. Manufacturers:
      a. Roxul Rockwool Safe® 55.
      b. Rockwool ProRox 960.
      c. Metacaulk Safing Mineral Wool.
      d. Owens Corning Thermafiber® SAFB.
      e. Johns Manville MinWool® Safing.
      f. Architect approved equivalent.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

H. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

I. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicted below:
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and non-sag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of non-sag grade for both opening conditions.

2.05 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, missing containers, missing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

2.06 CAVITY WALL FIREBLOCKING

A. Provide continuous, vertical safing insulation (unfaced mineral wool strips) within the exterior wall cavity at a spacing as shown on the Contract Drawings or at a maximum spacing necessary to create a maximum concealed area between vertical safing insulation strips of 100 SF of face area.
   1. Provide Owens Corning Thermafiber® TopStop® Mineral Wool Insulation or Architect approved equivalent.
      a. Mineral Wool Density: 6.0 pcf.
      b. Prefabricated Size: Top Width: 4-1/2"; Bottom Width: 5-1/2"; Thickness: 2".
      c. Field Cut Size: Width: 5"; Thickness: 2"

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:
   1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
   2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.03 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
   1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:
   1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
   2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

D. Cavity wall fireblocking.
   1. Temporarily secure installed vertical safing insulation strips (mineral wool strips) in cavity wall thru spray foam insulation with staples or other approved fastening systems.

2. Vertical safing insulation shall run continuous from top of foundation wall to top of wall at required spacing.
3. Safing insulation thickness should allow for a slight compression of the insulation as the veneer masonry and/or cladding is installed.
4. Through wall flashings should penetrate the vertical safing insulation strips.

3.04 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using contrasting color lettering not less than 3 inches high and with minimum 0.375-inch strokes. See specification section 09900 for additional information.

B. Install labeling required by code. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words “Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage”.
   2. Contractor’s name, address and phone number.
   3. Designation of applicable testing and inspecting agency, UL system, F-rating, T-rating, and the hourly rate of the wall.
   4. Date of installation.
   5. Manufacturer’s name, and product number.
   6. Installer’s name.

3.05 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings and or joints as the Work progresses by methods and with cleaning materials that are approved in writing by the firestopping manufacturers and that do not damage materials in which openings and/or joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping and joint firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated firestopping and install new materials to produce systems complying with specified requirements.

3.06 JOINT FIRESTOPPING SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN or Category XHDG.

B. Where Intertek Group listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Listed Building products" under product category Firestop Systems.

C. Head-of-Wall, Fire-Resistive Joint Firestopping Systems:
   1. UL Classified Systems: HW-S-0000-0999.
   2. Assembly Rating: As indicated on Contract Drawings.
   3. Nominal Joint Width: As indicated on Contract Drawings.
   4. Movement Capabilities: Class 1.

D. Perimeter Joint Firestopping Systems:
   1. UL Classified Perimeter Fire Containment Systems: CW-D-2000-2999.
   2. Integrity Rating: 1 hour.
   3. Insulation Rating: 1 hour.
   4. Linear Opening Width: As indicated, maximum.
   5. Movement Capabilities: Class II.
   6. F-Rating: 1 hour.

3.07 PENETRATION FIRESTOPPING SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Firestopping with No Penetrating Items:
   1. UL-Classified Systems: C-AJ-0001-0999.
   2. F-Rating: 1 or 2 hours.
   3. T-Rating: 1 hour
   4. Type of Fill Materials: As required to achieve rating.

C. Firestopping for Metallic Pipes, Conduit, or Tubing:
   1. UL-Classified Systems: C-AJ-1001-1999.
   2. F-Rating: 1 or 2 hours.
   3. T-Rating: 1 hour.
   4. Type of Fill Materials: As required to achieve rating.

D. Firestopping for Nonmetallic Pipe, Conduit, or Tubing:
   1. UL-Classified Systems: C-AJ-2001-2999.
   2. F-Rating: 1 hour to 2 hours.
   3. T-Rating: 1 hour.
   4. Type of Fill Materials: As required to achieve rating.

E. Firestopping for Electrical Cable:
   1. UL-Classified Systems: C-AJ-3001-3999.
   2. F-Rating: 1 hour or 2 hours.
   3. T-Rating: 1 hour.
   4. Type of Fill Materials: As required to achieve rating.

F. Firestopping for Miscellaneous Mechanical Penetrants:
   1. UL-Classified Systems: C-AJ-7001-7999.
   2. F-Rating: 1 hour or 2 hours.
   3. T-Rating: 1 hour.
   4. Type of Fill Materials: As required to achieve rating.

G. Firestopping for Groupings of Penetrants:
   1. UL-Classified Systems: C-AJ-8001-8999.
   2. F-Rating: 1 hour or 2 hours.
   3. T-Rating: 1 hour.
   4. Type of Fill Materials: As required to achieve rating.

+ + END OF SECTION + +

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SECTION 07844

FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Joints in or between fire-resistance-rated constructions.
   2. Joints at exterior curtain-wall/floor intersections.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency.
   1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.04 INFORMATIONAL SUBMITTALS

A. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

B. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications

include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

C. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:
   1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:
      a. Fire-resistive joint system products bear classification marking of qualified testing agency.
      b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:
      c. UL - “Fire Resistance Directory."

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.07 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

C. Notify Owner's testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.

D. Contractor shall coordinate fire resistive joint systems provided by all trades to ensure compatibility between types.

PART 2 - PRODUCTS

2.01 FIRE-RESISTIVE JOINT SYSTEMS

A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and

other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E1966 or UL 2079:
   1. Joints include those installed in or between fire-resistance-rated walls floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
   2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
   3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Hilti, Inc.
      b. 3M Fire Protection Products.
      c. Cemco - Cemco Hotrod Type-X.
      d. Or approved equal

C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide fire-resistive joint systems with rating determined by ASTM E119 based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa) or ASTM E2307.
   1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
   2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Hilti, Inc.
      b. 3M Fire Protection Products.
      c. Or approved equal.

D. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
   1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
   2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.03 INSTALLATION

A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
   1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
   1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
   2. Apply fill materials so they contact and adhere to substrates formed by joints.
   3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION

A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge

so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.05 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.

C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

3.06 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

3.07 FIRE-RESISTIVE JOINT SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN or Category XHDG.

B. Floor-to-Floor, Fire-Resistive Joint Systems:
   1. UL-Classified Systems: FF-S-1087 .
   2. Assembly Rating: 1 hour 2 hours.
   3. Nominal Joint Width: As indicated.

4. Movement Capabilities: Class I - 15 percent compression, extension, or horizontal shear.
5. L-Rating at Ambient: Less than 1 cfm/ft.
6. W-Rating: No leakage of water at completion of water leakage testing.

C. Wall-to-Wall, Fire-Resistive Joint Systems FRJS-Concrete or Block Wall Assembly:
1. UL-Classified Systems: WW-D-0032.
2. Assembly Rating: 1 hour 2 hours.

D. Floor-to-Wall, Fire-Resistive Joint Systems FRJS-Through Concrete Floor Assembly:
1. UL-Classified Systems: FW-D-1013 .
2. Movement Capabilities: Class I - 15 percent compression, extension, or horizontal shear.

E. Head-of-Wall, Fire-Resistive Joint Systems FRJS-Concrete or Block Wall Assembly, up to 2-hours:
1. UL-Classified Systems: HW-D-0081.

F. Perimeter Fire-Resistive Joint Systems PFRJS-Curtain Wall Assembly:
1. UL-Classified Perimeter Fire-Containment Systems: HI/BPF 120-27 or provide for an Engineering Judgement for Curtain Wall to Floor Slab Fire-Resistive Joint System.

+ + END OF SECTION + +

SECTION 07920

JOINT SEALANTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install calking and sealants.
   2. Extent of each type of calking and sealant is shown or indicated and includes the following:
      a. Interior and exterior joints in equipment and construction systems not filled by another material, and that are not required to be open for operation.
      b. Exposed-to-view joints of all fire-rated sealants.
      c. Joints specified to be recalked.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items to be installed with or before calking and sealants.
   2. Coordinate final selection of calking and sealants so that materials are compatible with all calking and sealant substrates specified.

C. Related Sections:
   1. Section 03300, Cast-In-Place Concrete.
   2. Section 03251, Concrete Accessories.
   3. Section 04090, Masonry Anchorage and Reinforcing.
   4. Section 07461, Preformed Metal Siding.
   5. Section 08111, Hollow Metal Doors and Frames
   6. Section 08800, Glass and Glazing.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM C510, Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
   2. ASTM C661, Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
   3. ASTM C793, Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
   4. ASTM C794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
   5. ASTM C920, Specification for Elastomeric Joint Sealants.
   6. ASTM C1021, Practice for Laboratories Engaged in Testing Building Sealants.
   7. ASTM C1087, Test method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
   8. ASTM C1193, Guide for Use of Joint Sealants.
   9. ASTM C1247, Practice for Durability of Sealants Exposed to Continuous Immersion in Liquids.
   10. BAAQMD Regulation 8, Rule 51.
   11. FS TT-S-00227, Sealing Compound: Elastomeric Type, Multi-component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
   12. 12. NSF/ANSI Standard 61, Drinking Water System Components - Health Effects.
   13. SCAQMD Rule 1168.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Installer:
      a. Engage a single installer, approved by product manufacturer, regularly engaged in calking and sealant installation and with successful experience in applying types of products required, and who employs only tradesmen with specific skill and successful experience in the type of Work required.
   2. Testing Laboratory:
      a. Furnish services of independent testing laboratory qualified according to ASTM C1021, for conducting testing required.

B. Component Supply and Compatibility:
   1. Obtain materials only from manufacturers who will, if required:
      a. Test calking and sealants for compatibility with substrates for conformance with FS-TT-S-00227, and recommend remedial procedures as required.
   2. Before purchasing each sealant, investigate its compatibility with joint surfaces, joint fillers, and other materials in joint system. Provide products that are fully compatible with actual installation condition, verified by manufacturer's published data or certification, and as shown on approved Shop Drawings and other approved submittals.

C. Product Testing: Provide test results of laboratory pre-construction compatibility and adhesion testing, as specified in Article 3.1 of this Section, by qualified testing laboratory, based on testing of current sealant formulations within a 36-month period preceding the Notice to Proceed for the Work.
   1. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920 and, where applicable, to other standard test methods.
   2. Test other joint sealants for compliance using specified post-construction field adhesion test.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of calking and sealants installation, indication each specific surface where calking or sealants are to be provided and the material proposed for each application.
   2. Product Data:
      a. Copies of manufacturer's data sheets including color charts, specifications, recommendations, and installation instructions for each type of sealant, caulking compound, and associated miscellaneous material required. Include manufacturer's published data, indicating that each product complies with the Contract Documents and is intended for the applications shown or indicated.
      b. Product test reports.
   3. Samples:
      a. Each type of actual cured material of each calking and sealant specified, in each of manufacturer's standard colors.
      b. Samples will be reviewed by Engineer for color and texture only. Compliance with other requirements is responsibility of Contractor.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certify that materials are suitable for intended use and materials meet or exceed requirements of the Contract Documents.

b. Certification from manufacturer that products furnished are appropriate for surfaces and conditions to which they will be applied.
c. Certify that applicator is approved by manufacturer.

2. Field Quality Control Submittals:
   a. Pre-construction and post-construction field test reports.
   b. Compatibility and adhesion test reports.
   c. Contractor's Field Test Report Logs:
      1) Indicate time present at the Site.
      2) Include observations and results of field tests, and document compliance with manufacturer's installation instructions and supplemental instructions provided to installers.
3. Qualifications: Submit qualifications for:
   a. Installer.
   b. Testing laboratory (if not already submitted under Section 01416, Special Inspections furnished by Owner, or Section 01416, Special Inspections Furnished by Contractor).

C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
   a. Recommended inspection intervals.
   b. Instructions for repairing and replacing failed sealant joints.
2. Warranty: Submit written warranties as specified in this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery of Products:
1. Deliver products in calking and sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings and approved Sample color selections.
2. Include the following information on label:
   1) Name of material and Supplier.
   2) Formula or Specification Section number, lot number, color and date of manufacture.
   3) Mixing instructions, shelf life, and curing time, when applicable.

B. Storage of Products:
1. Do not store or expose materials to temperature above 90 degrees F or store in direct sunlight.
2. Do not use materials that are outdated as indicated by shelf life.
3. Store sealant tape in manner that will not deform tape.
4. In cool or cold weather, store containers for sixteen hours before using in temperature of approximately 75 degrees F.
5. When high temperatures prevail, store mixed sealants in a cool place.

C. Handling:
1. Do not open containers or mix components until necessary preparatory Work and priming are complete.

1.6 JOB CONDITIONS

A. Environmental Conditions:
1. Do not install calking and sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
2. Proceed with the Work when forecasted weather conditions are favorable for proper cure and development of high-early bond strength.
3. Where joint width is affected by ambient temperature variations, install elastomeric sealants when temperatures are in the lower third of manufacturer's recommended installation

temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.

4. When high temperatures prevail, avoid mixing sealants in direct sunlight.
5. Supplemental heat sources required to maintain both ambient and surface temperatures within the range recommended by manufacturer for material applications are not available at the Site.
6. Provide supplemental heat and energy sources, power, equipment, and operating, maintenance, and temperature monitoring personnel.
7. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas of calking, sealants, and painting Work, and areas where Owner's personnel or construction personnel may work. Properly locate and vent such heat sources to outdoors so that calking and sealants and other Work are unaffected by exhaust.

1.7 WARRANTY

A. Provide written warranty, signed by manufacturer and Contractor, agreeing to repair or replace sealants that fail to perform as air-tight and watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified in approved Shop Drawings and other submittals, as an inherent quality of material for exposure indicated.
   1. Provide manufacturer warranty for period of one year from date of Substantial Completion of calking and sealants Work.
   2. Provide installer warranty for period of two years from date of Substantial Completion of calking and sealants Work.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Provide elastomeric joint sealants for interior and exterior joint applications that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. VOC Performance Criteria:
   1. VOC content of sealants used shall comply with current VOC content limits of SCAQMD Rule 1168. Sealants used as fillers shall comply with or exceed requirements of BAAQMD Regulation 8, Rule 51.
      a. Sealants: 250 g/L.
      b. Sealant Primers for Nonporous Substrates: 250 g/L.
      c. Sealant Primers for Porous Substrates: 775 g/L.

C. Provide colors selected by Engineer from calking and sealant manufacturer's standard and custom color charts. "Or equal" manufacturers shall provide same generic products and colors as available from manufacturers specified.

2.2 MATERIALS

A. Exterior and Interior Horizontal and Vertical Joints; Submerged and Intermittently Submerged in Potable Water or Water That Will be Treated to Become Potable:
   1. Two-component Polyurethane Sealant:
      a. Products and Manufacturers: Provide one of the following:
         1) Sikaflex- 2c NS by Sika Corporation.
         2) Vulkem 245 by Tremco Sealant/Waterproofing Division of RPM International, Inc.

3) Or equal.

b. Two-component, moisture cured, gun grade, polyurethane sealant, complying with:
   1) FS TT-S-00227E, Type II, Class A; ASTM C920, Type M, Grade NS, Class 25.
   2) Adhesion-in-Peel, FS TT-S-00227E, ASTM C794 (Minimum five pounds per linear inch with no adhesion failure): 18 pounds.
   3) Hardness (Standard Conditions), ASTM C661: 25 (Shore A).
   4) Stain and Color Change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
   5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
   6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
   7) VOC Content: 220 g/L, maximum.
   8) Listed in NSF/ANSI 61

B. Exterior and Interior Horizontal and Vertical Joints; Submerged and Intermittently Submerged in Wastewater:
   1. Two-component Polyurethane Sealant:
      a. Products and Manufacturers: Provide one of the following:
         1) Sikaflex- 2c NS by Sika Corporation.
         2) Vulkem 227 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
         3) Or equal.
      b. Polyurethane based, two-component elastomeric sealant complying with:
         1) FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
         2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 18 lbs.
         3) Hardness (Standard Conditions), ASTM C661: 25 (Shore A).
         4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
         5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
         6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
         7) VOC Content: 220 grams per liter, maximum.

C. Exterior and Interior Vertical Joints; Non-submerged:
   1. Two-component Polyurethane Sealant:
      a. Products and Manufacturers: Provide one of the following:
         1) Sikaflex- 2c NS by Sika Corporation.
         2) Dymeric 240 FC by Tremco Sealant/Waterproofing Division of RPM International, Inc.
         3) Or equal.
      b. Polyurethane based, two-component elastomeric sealant complying with:
         1) FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
         2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 10 pounds.
         3) Hardness (Standard Conditions), ASTM C661: 25 to 35 (Shore A).
         4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
         5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
         6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
         7) VOC Content: 100 g/L, maximum.

D. Exterior and Interior Horizontal Joints; Non-submerged:
   1. Two-component Polyurethane Sealant:
      a. Products and Manufacturers: Provide one of the following:
         1) Sikaflex- 2c SL by Sika Corporation.
         2) THC/900 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
         3) Or equal.
      b. Polyurethane based, two-component elastomeric, self-leveling sealant complying with the following:
         1) FS TT-S-00227E, Type I (self-leveling) Class A. and ASTM C920, Type M, Grade P, Class 25
         2) Water Immersion Bond, FS TT-S-00227E: Elongation of 50 percent with no adhesive failure.
         3) Hardness (Standard Conditions), ASTM C661: 35 to 45.
         4) Stain and Color Change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
         5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
         6) VOC Content: 165 g/L, maximum.

E. Miscellaneous Materials:
   1. Joint Cleaner: As recommended by calking and sealant manufacturer.
   2. Joint Primer and Sealer: As recommended for compatibility with calking and sealant by calking and sealant manufacturer.
   3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended for compatibility with calking and sealant by calking and sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of calking and sealant. Provide self-adhesive tape where applicable.
   4. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended for compatibility with calking and sealant by calking and sealant manufacturer. Provide size and shape of rod that will control joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide highly-compressible backer to minimize possibility of sealant extrusion when joint is compressed.
   5. Low-temperature Catalyst: As recommended by calking and sealant manufacturer.

F. Products for Other Applications:
   1. Glazing Sealants: Refer to Section 08800, Glass and Glazing.
   2. Fire-Rated Sealants: Refer to Section 07210, Building Insulation.
   3. Compressible Filler: Refer to Section 04090, Masonry Anchorage and Reinforcing.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and conditions under which calking and sealant Work will be performed, and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work and performance of sealants. Do not proceed with calking and sealant Work until unsatisfactory conditions are corrected.

B. Laboratory Pre-construction Compatibility and Adhesion Testing: Submit to joint sealant manufacturers for testing indicated below samples of materials that will contact or affect joint sealants.

1. Use ASTM C1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit at least eight pieces of each type of material, including joint substrates, shims, joint sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For products that fail tests, obtain joint-sealant manufacturer's written instructions for corrective measures including using specially formulated primers.
5. Immersion Testing: ASTM C1247 for potable water and wastewater.
6. Testing will not be required if joint sealant manufacturers submit joint preparation data based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted and mock-up field testing is acceptable.

3.2 PREPARATION

A. Protection: Do not allow calking and sealants to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or calking and sealant materials.

B. Joint Surface Preparation:
   1. Clean joint surfaces immediately before installing sealant compound. Remove dirt, weakly adhering coatings, moisture and other substances that would interfere with bonds of sealant compound as recommended in sealant manufacturer's written instructions as shown on approved Shop Drawings.
   2. If necessary, clean porous materials by grinding, sandblasting, or mechanical abrading. Blow out joints with oil-free compressed air or by vacuuming joints prior to applying primer or sealant.
   3. Roughen joint surfaces on vitreous coated and similar non-porous materials, when sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.
   4. Concrete Joint Preparation: Refer to Section 03251, Concrete Accessories

C. Mixing:
   1. Comply with sealant manufacturer's written instructions for mixing multi-component sealants.
   2. Thoroughly mix components before use.
   3. Add entire contents of activator can to base container. Do not mix partial units.
   4. Mix contents for minimum of five minutes or as recommended by sealant manufacturer, until color and consistency are uniform.

3.3 INSTALLATION

A. Install calking and sealants after adjacent areas have been cleaned and before joint has been cleaned and primed, to ensure calking and sealant joints will not be soiled. Replace calking and sealant joints soiled after installation.

B. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or indicated in the Contract Documents, only as acceptable to Engineer.

C. Prime or seal joint surfaces as shown on approved Shop Drawings and approved other submittals. Do not allow primer or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to applying sealants.

D. Apply masking tape before installing primer, in continuous strips in alignment with joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.

E. Confirm that compressible filler is installed before installing sealants. Refer to Section 04201, Unit Masonry Construction, for locations.

F. Do not install sealants without backer rods and bond breaker tape.

G. Roll back-up rod stock into joint to avoid lengthwise stretching. Do not twist, braid, puncture, or prime backer rods.

H. Employ only proven installation techniques that will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

I. Install sealants to depths recommended by sealant manufacturer but within the following general limitations, measured at the center (thin) section of bead.
   1. For horizontal joints in sidewalks, pavements, and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
   2. For vertical joints subjected to normal movement and sealed with elastomeric sealants and not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.

J. Remove excess and spillage of compounds promptly as the Work progresses.

K. Cure calking and sealant compounds in compliance with manufacturer's instructions and recommendations, to obtain high-early bond strength, internal cohesive strength, and surface durability.

3.4 FIELD QUALITY CONTROL

A. Post-construction Field Adhesion Testing: Before installing elastomeric sealants, field-test joint sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed elastomeric sealant joints as follows:
      a. Perform ten tests for the first 1,000 feet of joint length for each type of elastomeric sealant and joint substrate.
      b. Perform one test for each 1,000 feet of joint length thereafter, and minimum of one test per each floor per elevation.
      c. Test Method: Test joint sealants according to Method A, Field-applied Sealant Joint Hand Pull Tab, and Method D, Water Immersion in Appendix X1 of ASTM C1193. For joints with dissimilar substrates, verify adhesion to each substrate separately by extending cut along one side and verifying adhesion to opposite side. Repeat procedure for opposite side.
      d. Inspect joints for complete fill, absence of voids, and joint configuration complying with specified requirements. Record results in a log of field adhesion tests.
      e. Inspect tested joints and report on whether:
         1) Sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type

of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

2) Sealants filled the joint cavities and are free of voids.
3) Sealant dimensions and configurations comply with specified requirements.

f. Record test results in a log of field adhesion tests. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.

g. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

h. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other requirements will be satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

i. Do not proceed with installation of elastomeric sealants over joint surfaces that have been painted, lacquered, waterproofed, or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with FS TT-S-00227, has successfully demonstrated that sealant bond is not impaired by the coating or treatment. If laboratory test has not been performed or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

B. Water Leak Testing: Field test for water leaks as follows:

1. Flood the joint exposure with water directed from a 3/4-inch diameter garden hose, without nozzle, held perpendicular to wall face, two feet from joint and connected to water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.
2. Test approximately five percent of total joint system, in locations that are typical of every joint condition, and that can be inspected easily for leakage on opposite face. Conduct test in presence of Engineer, who will determine actual percentage of joints to be tested and actual period of exposure to water from hose, based on extent of observed leakage or lack of observed leakage.
3. Where nature of observed leaks indicates potential of inadequate joint bond strength, Engineer may direct that additional testing be performed at a time when joints are fully cured, and before Substantial Completion.

3.5 ADJUSTING AND CLEANING

A. Where leaks and lack of adhesion are evident, replace sealant.

B. Clean adjacent surfaces of sealant and soiling resulting from the Work. Use solvent or cleaning agent recommended by sealant manufacturer. Leave all finish Work in neat, clean condition.

C. Protect sealants during construction so that they will be without deterioration, soiling, or damage at time of readiness for final payment of the Contract.

3.6 PROTECTION

A. During and after curing period, protect joint sealants from contact with contaminating substances and from damage resulting from construction operations or other causes, so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original Work.

+ + END OF SECTION + +

SECTION 07950

EXPANSION CONTROL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Interior expansion control systems around blower foundations and building perimeter.

1.03 ACTION SUBMITTALS

A. Shop Drawings: For each expansion control system specified. Include plans, elevations, sections, details, splices, blockout requirement, attachments to other work, and line diagrams showing entire route of each expansion control system. Where expansion control systems change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

B. Samples: For each exposed expansion control system and for each color and texture specified, full width by 6 inches (152 mm) long in size.

C. Product Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
   1. Manufacturer and model number for each expansion control system.
   2. Expansion control system location cross-referenced to Drawings.
   3. Nominal joint width.
   4. Movement capability.
   5. Classification as thermal or seismic.
   6. Materials, colors, and finishes.
   7. Product options.

1.04 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire barrier provided as part of an expansion control system, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. General: Provide expansion control systems of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.
   1. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where expansion control systems change direction or abut other materials.
   2. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion control systems.

B. Coordination: Coordinate installation of exterior wall expansion control systems with roof expansion control systems to ensure that wall transitions are watertight. Roof expansion joint assemblies are specified elsewhere.

2.02 MATERIALS

A. Elastomeric Seals: Synthetic rubber seals comprised of a dual extrusion Santoprene rubber for heat welding of all transitions and seams for a monolithic, weathertight installation. EPDM and Neoprene substitutions are not allowed due to their lack of ability to meet this specific requirement.
   1. All Santoprene seals must be certified as low VOC as certified by UL Environmental GreenGuard Gold Certification

B. Cellular Foam Seals: Extruded, compressible foam designed to function under compression.

C. Horizontal and Vertical Insulated Moisture Barrier (provide optional accessory):
   1. Min. R Value of 15
   2. Must meet ASTM E1399 Cyclic movement requirements matching movement requirements specific to project.

D. Compression Seals: ASTM D2000; preformed rectangular elastomeric extrusions having internal baffle system and designed to function under compression.

E. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to meet performance criteria for required rating period.

F. Accessories: Manufacturer's standard anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.03 INTERIOR EXPANSION CONTROL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or a comparable product by one of the following:
   1. Inpro Corporation. (Basis of Design for floor to curb)
   2. Sika Emseal (Basis of Design for building perimeter)
   2. Construction Specialties, Inc.
   3. Balco, Inc.
   4. MM Systems Corporation.

C. Source Limitations: Obtain expansion control systems from single source from single manufacturer.

D. Floor-to-Curb:
   1. Basis-of-Design Product: Inpro Foam Seals.
   2. Type: Waterproof Foam Seals, ASTM E1399.
   3. Model: Inpro 1175 Series
      a. Open cell polymer foam seal with factory applied traffic grade silicone face.
   4. Design Criteria:
      a. Nominal Joint Width: 2 inch or as indicated on the drawings
      b. Load Capacity:
         1) Uniform Load: Moderate
      c. Fire Resistance: Provide joint system and fire-barrier assembly with a rating not less than that of adjacent construction.
      d. Movement: 50%
   5. Attachment Method: Epoxy Adhesive.
   6. Warranty: Five-Year Warranty

E. Building Perimeter:
   1. Basis-of-Design Product: Emshield by Sika Emseal
   2. Type: Watertight structural fire rated expansion joint, proof Foam Seals, ASTM E1966.
   3. Model: Emshield DFR2 Series
      a. Pre-compressed foam seal with factory applied traffic grade silicone face.
   4. Design Criteria:
      a. Nominal Joint Width: up to 4 inches or as indicated on the drawings
      b. Fire Resistance: Provide joint system and fire-barrier assembly with a rating not less than that of adjacent construction, 2-hours.
      c. Movement: 100%, 50% compression and 50% expansion.
   5. Silicone: Field applied sealant band at face of seal to substrate interface, furnished by joint seal manufacturer; same material and color as factory coating.
      a. Abrasion resistance: Maximum 1 percent weight loss, tested to ASTM D4060.

b. Fuel resistance: Pass ASTM C719 and ASTM C1135.

6. Intumescent Sealant: Field applied to face of joints, furnished by joint seal manufacturer.
7. Attachment Method: Epoxy Adhesive.
8. Color: As selected by Architect from manufacturer's full range.

2.04 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces where expansion control systems will be installed for installation tolerances and other conditions affecting performance of work.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Prepare substrates according to expansion control system manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion control systems. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion control systems.

3.03 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion control systems and materials unless more stringent requirements are indicated.

B. Foam Seals: Install with adhesive recommended by manufacturer.

C. Terminate exposed ends of expansion control systems with field- or factory-fabricated termination devices.

3.04 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion control systems. Reinstall cover plates or seals prior to Substantial Completion of the Work.

+ + END OF SECTION + +

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SECTION 08111

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Agreement, including General and Division 01 of the Project Manual, apply to work of this Section.

1.02 SUMMARY

A. This Section includes the following products manufactured in accordance with Steel Door Institute (SDI) Recommended Standards:
   1. Doors: Flush, hollow or composite construction standard steel doors for interior locations.
   2. Frames: Pressed steel frames for interior doors of the following type:
      a. Welded unit type, all locations.
   3. Assemblies: Provide standard steel door and frame assemblies as required for the following:
      a. Labeled and fire-rated.
      b. STC acoustically rated.
   4. Provide factory primed doors and frames to be field painted.
   5. Hollow Metal Doors and Frames to be provided only for STC rated doors in the Blower Room.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Section 08710 - Door Hardware.
   2. Section 09900 - Painting.

1.03 STANDARDS

A. All work of this section shall conform to industry standards and/or manufacturer’s recommendations.

B. ANSI/BHMA A156.115 - "Hardware Preparation in Steel Doors and Frames".

C. ANSI/SDI A250.4 - "Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frame Anchors, and Hardware Reinforcing".

D. ANSI/SDI A250.6 - "Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames".

E. ANSI/SDI A250.8 - "Specifications for Standard Steel Doors and Frames".

F. ANSI/SDI A250.10 - "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames".

G. ANSI/SDI A250.11 - "Recommended Erection Instructions for Steel Frames".

H. ASTM A569 - "Standard Specification for Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality".

I. ASTM E152 - "Standard Methods of Fire Tests of Door Assemblies".

J. ASTM E331 - "Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference".

K. NFPA 80 - "Standard for Fire Doors and Opening Protectives".

L. NFPA 257 - "Standard on Fire Test for Window and Glass Block Assemblies".

1.04 SUBMITTALS

A. Submit pursuant to Section 01300 - Submittals.

B. Certification: Manufacturer is a current member of the Steel Door Institute (SDI).

C. Product Data: Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes for each type of product required.

D. Shop drawings showing dimensions, materials, adjacent wall construction, accessories and all other information needed for a complete system.
   1. Provide schedule of doors and frames using same reference numbers for details and openings as those on the Contract Drawings.
   2. Indicate coordination of glazing frames and stops with glass and glazing requirements.
   3. Details of conduit and preparations for power, signal, and control systems.
   4. Show required supplemental reinforcements to frames and hollow metal doors either specified or required by hardware specified or submitted.

E. Label Construction Certification: For door assemblies required to be fire-rated and exceeding limitations of labeled assemblies, submit manufacturer's certification that each door and frame assembly has been constructed to conform to design, materials and construction equivalent to requirements for labeled construction.

F. Sample warranties: Submit sample warranties of those to be furnished upon project completion. Warranties must meet or exceed all requirements of the Warranty paragraph below.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal frames and doors through one source, from a single manufacturer whenever possible.

B. Provide doors and frames complying with Steel Door Institute “Specifications Standard Steel Doors and Frames” ANSI/SDI A250.8 (SDI-100) latest edition and as herein specified.

C. Membership in good standing in the Steel Door Institute is required. Architect reserves the right to require proof of membership prior to accepting any items described by or related to this Section.

D. Fire-Rated Door Assemblies: Units that comply with NFPA 80, are identical to door and frame assemblies whose fire resistance characteristics have been determined per ASTM E 152 and which are labeled and listed by UL, Factory Mutual, Warnock Hersey, or other testing and inspecting organization acceptable to authorities having jurisdiction.

E. Hot-Rolled Steel Sheets and Strips: Commercial-quality carbon steel, pickled and oiled, complying with ASTM A 569 (ASTM A 569M), free of scale, pitting, or surface defects.

1.06 DELIVERY, STORAGE AND HANDLING

A. Pursuant to manufacturers published instructions.

B. Deliver, handle, and store doors, and frames at job site in such a manner as to prevent damage.

C. Inspect doors and frames upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to Architect; otherwise, remove and replace damaged items as directed.

D. Protect against moisture exposure and damage. Store doors and frames at building site under cover.

E. Store doors, and frames in a vertical position on minimum 4" high blocking, clear of floor and with blocking between doors to permit air circulation between doors. Place in stacks of five units maximum.

F. Carefully protect frames from twisting or racking and preserve the integrity of spreader bars.

G. Immediately remove from job site all damaged or otherwise unsuitable door, and frame.

1.07 PROJECT CONDITIONS

A. Field Measurements: Verify openings by field measurements before fabrication and indicate measurements on Shop Drawings.
   1. Establish Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating hollow metal frames without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.08 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts and items with integral anchors. Deliver such items to Project site in time for installation.

1.09 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering standard steel doors and frames which may be incorporated in the Work, but are not limited to, the following:
   1. Krieger Specialty Products.
   2. Amweld Building Products; Black Mountain Door
   3. Ceco Door Products; an ASSA ABLOY Group Company
   4. Curries Company; an ASSA ABLOY Group Company
   5. de La Fontaine Industries, Inc.
   6. Fleming Door Products Ltd; an ASSA ABLOY Group Company
   7. Pioneer Industries, an ASSA ABLOY Group Company
   8. Republic Doors & Frames, an Allegion PLC Company
   9. Steelcraft; an Allegion PLC Company

2.02 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 metallic coating, mill phosphatized.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.
   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011 M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Kerf Gasketing: Durable, UV resistant, polyethylene cladding covering a urethane foam gasket. Gasket material shall comply with UL 10C. Gaskets shall have passed the water penetration test up to 34 mph per ASTM E331.
   1. Kerf Gasketing shall be supplied by the hollow metal frame provider.

F. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

G. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

H. Grout: Comply with requirements for grout in Division 03 Section “Grouting”.

I. Glazing: Furnished and installed by Division 08 Section “Glazing and Glass”.

2.03 FINISH

A. All Steel Doors and Frames shall be factory prepped.
   1. Galvanize pursuant to ASTM A653, Grade A60 or G60; to ASTM A591, Class A.
   2. Clean, phosphate treat, and paint with a rust inhibitive primer pursuant to ANSI A250.10-2011, applied after fabrication.
   3. Reinforcements for galvannealed doors and frames are to be galvannealed.

2.04 FABRICATION

A. Fabricate steel door and frame units to be rigid, neat in appearance and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer’s plant. Clearly identify work that cannot be permanently factory-assembled before shipment, to assure proper assembly at Project site. Comply with ANSI/SDI-100 requirements.
   1. Provide beveled hinge and lock edges.

B. Fabricate sidelite and transom frames with closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.

2.05 HARDWARE

A. Factory prepare all doors, and frames for hardware pursuant to ANSI A115; ANSI A151; SDI 107; and SDI 111-E. See Door Schedule and Section 08710 - Door Hardware.

B. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware in accordance with final Door Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 Series Specification for door and frame preparation for hardware.

C. Locate hardware as indicated on final shop drawings or, if not indicated, in accordance with "Recommended Locations for Builder's Hardware on Standard Steel Doors and Frames," published by Door and Hardware Institute.

2.06 INTERIOR DOORS:

A. Grade: I, Standard Duty, 1-3/4 in. thick.
   1. Class/rating per drawings - UL approved

B. Full flush-hollow steel.

C. Core:
   1. Fire Rated: Mineral Fiber

D. Door Edge Construction: Seamless Edge, No visible edge seam.

E. Metal thickness: 16 gauge galvannealed steel.
   1. Construction, and galvanized finish: Pursuant to SDI - 100.

F. Top and Bottom Edges: Closed with inverted 14-gauge welded channels.
   1. Bottom channels of all rated and smoke tight doors to be provided with concealed double sealing sweeps equivalent to Steelcraft FAS-SEAL™.

G. Doors for fire rated openings:
   1. Provide labeled doors with fire rating per door schedule.

H. Reinforce doors scheduled to have closers with optional 12-gauge closer reinforcements.

I. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" unless noted otherwise.

J. Provide cylinder lock reinforcement. rim exit reinforcement, flush bolt lock reinforcement or mortise lock reinforcement per specified lock type.

2.07 FRAMES

A. Welded Frames: All frames shall be saw miter welded construction.
   1. Weld joints continuously through full throat width of frames, including rabbets, soffits, and stops: grind, fill, dress, and make smooth, flush, and invisible.
   2. All hollow metal frames shall have back bend returns.
   3. Provide with two steel spreaders, temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling.

B. Provide frames in following types:
   1. Height: 84” frame with 2” head for all stud openings unless noted otherwise.
   2. Height: 84” frame with 4” head for all masonry openings unless noted otherwise.
   3. Interior door frames where indicated on Door Schedule to have integral 1/8” kerf for additional weatherstripping.
   4. Frames for doors scheduled to have door closers, provide full closer sleeve reinforcement.
   5. All hinge reinforcements shall have a mudcap.
   6. High Frequency Hinge Reinforcement: 10 gauge minimum auxiliary hinge reinforcement to 7 gauge minimum hinge reinforcements. Door frames between “Living Side” and apparatus bay(s) shall be provided with high frequency hinge reinforcements at all hinge locations. Provide high frequency hinge reinforcement on doors and frames at other locations specifically noted on the Contract Drawings.
   7. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge straps for continuous hinges specified in hardware sets in Division 08 Section “Door Hardware”.
   8. Provide other frame "preps" and reinforcements as required to accommodate the hardware and accessories specified in the Hardware Schedule.
   9. Provide either factory or distributor installed frame back coating (waterborne asphaltic emulsion coating) or additional field applied primer as indicated in this section.
      a. All grouted frames in masonry openings - back coating shall be waterborne asphaltic emulsion type coating.

C. Frames for fire rated openings:
   1. Provide frames with same hourly rating as door opening.

D. Interior opening metal thickness:
   1. Frames of 6' - 4" or less in width: Grade I, 16 gauge unless noted otherwise.
   2. Frames of 6' - 5" to 9' -0" in width: Grade I, 14 gauge unless noted otherwise.
      a. Provide with 12 gauge full width channel head reinforcement.
   3. Frames of 9' - 1" or greater in width: Grade I, 12 gauge unless noted otherwise.
      a. Provide with 12 gauge full width channel head reinforcement.

2.08 FIRE RATED OPENING ASSEMBLIES

A. Provide labels on rated doors and frames.
   1. Approved testing agencies for source of labels: Underwriters Laboratories and Factory Mutual.

2.09 SOUND RATED OPENING ASSEMBLIES

A. Provide steel door and frame assembles:
   1. STC rating of 40 or better.
   2. 3/4 hr fire rating.

2.10 ACCESSORIES

A. Grout Guards
   1. Formed from same material as frames, not less than 0.016 inch thick.
   2. Weld guards to frame at back of hardware mortises in frames to be grouted.

B. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

2.11 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by installing contractor.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Prepare written report, endorsed by installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Install standard steel doors, frames, and accessories in accordance with final approved shop drawings, manufacturer's installation instructions, and as herein specified.

B. Drill and tap doors and frames to receive non-templated, mortised, and surface mounted hardware.

C. Frame Back Painting:
   1. If factory or distributor back coating is furnished touch-up areas of the frame with back coating to cover any bare or primer metal on the inside of the frame. If not factory or distributor back coated, comply with paragraphs 2 and 3.
   2. All metal door frames to be installed in masonry and exterior walls shall have all hidden surfaces field painted with an additional coat of primer prior to installation. See Section 09900 - Painting.
      a. All grouted frames in masonry openings - back coating shall be waterborne asphaltic emulsion type coating.
   3. All metal door frames to be installed in interior non-masonry walls shall have all hidden surfaces field painted with an additional coat of primer from floor level to 48-inches above finish floor prior to installation. See Section 09900 - Painting.
      a. Additional field primer coating must be of a different color than factory primer.

D. Placing Frames: Comply with provisions of SDI-119 and SDI-105 "Recommended Erection Instructions for Steel Frames", unless otherwise indicated.
   1. Erect frames plumb, level, and square; free of racking, warping, or bowing; for effort-free door operation and without gravity-imposed movement upon door anywhere within door swing.
   2. Except for frames located at existing concrete, masonry or drywall installations, place frames prior to construction of enclosing walls and ceilings. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged. If screws and/or expansion anchors are required, frames shall be dimpled, and countersunk fasteners utilized.
   3. In masonry construction, locate three (3) wall anchors per jamb adjacent to hinge locations on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry Tee anchors.
   4. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
   5. Install door silencers in frames before grouting.
   6. In metal stud partitions, install at least three (3) wall anchors per jamb at hinge and strike levels. In closed steel stud partitions, attach wall anchors to studs with screws.

7. Head Anchors: Two anchors per head for frames more than 42 inches wide and mounted in metal stud partitions. Four head anchors for frames more than 76 inches wide and mounted in metal stud partitions.
8. Install fire-rated frames in accordance with NFPA Standard No. 80.
9. Metal Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
10. After wall construction is complete, remove temporary braces, leaving surfaces smooth, flush and undamaged.

E. Door Installation: Fit hollow metal doors accurately in frames, within clearances specified in ANSI/SDI-100.
   1. Install fire-rated doors with clearances as specified in NFPA Standard No. 80.

3.03 ADJUST AND CLEAN

A. Prime Coat Touch-up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer, providing for a continuous unbroken primer coating. Clean and remove any grout and or mortar smears on door frames.

B. Immediately after installation: Clean and remove any grout and or mortar smears on door frames.

C. Cover countersunk exposed screw heads with epoxy metal filler. Finish smooth and level with frame.

D. Finish Paint per Section 09900 - Painting

E. Protection Removal: Immediately prior to final inspection, remove protective plastic wrappings from prefinished doors.

F. Final Adjustments: Check and readjust operating hardware items, leaving steel doors and frames undamaged and in complete proper operating condition. Shims used for alignment purposes must be inserted between hinge and frame. Do not insert shims between hinge and door. Shims shall not be visible.

+ + END OF SECTION + +

SECTION 08131

STAINLESS STEEL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The Contractor shall furnish and install all doors, frames, transoms, sidelights, and associated equipment shown on the Contract Drawings and specified herein.

B. The Contractor shall be responsible for coordinating all work in this Section with work covered under Section 08710 - Finish Hardware.

1.02 RELATED SPECIFICATIONS

A. Section 08710 - Finish Hardware

B. Section 08800 - Glass, Plastic and Glazing

1.03 REFERENCE

A. All work shall comply with the New York State Building Code.

B. All work shall be fabricated in compliance with the Hollow Metal Manufacturer's Association, the Steel Door Institute and these Specifications.

C. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.

D. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.

E. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.

F. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.

G. ASTM A167-99: Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

H. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.

I. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.

J. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.

K. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.

L. UL 10C (1998) - Positive Pressure Fire Tests of Door Assemblies; UL 1784 (2001) - Standard for Air Leakage Tests of Door Assemblies.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Division 1, the Contractor shall submit the following:
   1. Samples.
   2. Working Drawings.
   3. Test Reports.
   4. Letters of Transmittal.

B. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed materials compliance with the Contract Documents.

C. Samples shall include:
   1. Corner sections of frames and trim.
   2. Cut-away corner sections of hollow metal doors showing internal reinforcement specified.
   3. Insulating material.

D. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.

E. Templates: Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.

F. Shop Drawings shall include, but not be limited to:
   1. Complete layout and installation drawings and schedules with clearly marked dimensions. Drawings shall indicate details of construction, profiles, gauges, reinforcing and location of all doors and frames.
   2. Include details of each door and frame type with elevations of door design types, conditions at openings, details of construction, location and installation requirements for all finish hardware and finish hardware reinforcements and details at joints, connections and every typical composite member. Show all door and frame reinforcements including welds, plate lengths, locations and gauges for each component of finish hardware.
   3. Provide a schedule of doors and frames using same reference numbers for details and openings as those on the Drawings.
   4. Provide submittal coordinated with requirements for finish hardware. Provide all template information and internal reinforcement gauges, sizes and locations.

Submit finish hardware template requirements with stainless steel door and frame submittal.

G. Test Reports: Submit for approval the following:
   1. Certification of Labeled Construction for fire doors and frames.
   2. Certification of Labeled Construction for doors not requiring labels but requiring labeled construction.
   3. Certified laboratory test report for required performance and specified feature verification for doors and frames selected at random by Engineer for testing. At least one test shall be to verify the presence of specified Type 316 alloy for use on all doors and frames brought to the site.
   4. Provide copies of material purchase receipts, for material used in this Contract, signed by a certified and licensed Notary Public, verifying that material purchased for the work complies with material designations specified as confirmed by approved Working Drawings.
   5. Final approval of all door and frame work shall be contingent upon verification of presence of all features specified. Submit report to the Engineer for approval.

H. Letters of Transmittal: Submit letters of transmittals indicating that door and frame manufacturer has received all finish hardware template and reinforcement information before start of fabrication.

1.05 QUALITY ASSURANCE

A. Provide stainless steel doors and frames and accessories manufactured by a single firm specializing in the production of this type of Work and complying with specified standards of ANSI, NFPA, SDI and UL.

B. Requirements of Regulatory Agencies:
   1. Fire rated Assemblies: Wherever fire-resistance classification is shown or scheduled for stainless steel doors and frames (3-hour, 1-1/2-hour, and similar designations), provide fire-rated assemblies investigated and tested as complete assemblies including type of fire door hardware to be used. Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 (neutral pressure at 40" above sill) or UL 10C. Identify each fire door, frame and stick system assembly with recognized testing laboratory labels, indicating applicable fire rating of both door, frame and stick assembly.
      a. Temperature-Rise Limit: At vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
   2. Oversize Assemblies: Wherever stainless steel assemblies are larger than size limitations established by NFPA, provide manufacturer's certification that assembly has been constructed with material and methods equivalent to labeled construction.

C. Source Quality Control:
   1. After Working Drawing approval by the Engineer, manufacturer shall not make any further detailing, fabrication or specific construction changes, nor shall doors and frames be brought to the site which do not conform in all ways to approved Working Drawing submittal.
   2. Doors and frames which are found to differ in any way from those approved by the Engineer at time of Working Drawing approval shall be removed from the work and replaced with doors and frames meeting requirements, even if discovered in the finished work, at no additional expense to the County.
   3. The Contractor shall provide testing of up to five stainless steel flush doors and frames, selected at random by Engineer from those brought to the site for the purpose of verifying, by independent laboratory analysis, the provision of all features specified and indicated on approved Working Drawings. Any door and frame found failing to comply with specified features shall require the removal of all doors and frames from the Project Site, even if discovered after door and frame installation, and the provision of units complying with specifications as confirmed by independent laboratory testing, at no additional expense to the County
   4. Discovery of such non conforming work shall require a complete review of all door and frame work on site and in shop. The Contractor shall prepare additional reports and provide additional testing in order to verify to the Engineer the acceptable condition of the remainder of all other door and frame work, at no additional expense to the County.

1.06 DELIVERY, STORAGE AND HANDLING

A. All materials shall be boxed or crated and suitably protected prior to shipment from the factory. Protection shall be arranged to protect all hardware which may be attached.

B. The Engineer will inspect stainless steel doors and frames upon delivery for damage. Minor damage may be repaired provided the finish items are equal to new work and acceptable to the Engineer; otherwise, remove and replace damaged items with new items meeting the requirements of this Specification.

C. Failure of the Engineer to discover damaged items at time of product delivery shall not relieve the Contractor of its requirement to only include in the finished work items meeting the requirements of this Specification.

D. Storage of Material:
   1. Store doors and frames at the building site under cover.
   2. Place units up off the floor and not in contact with dirt, other construction materials or debris and away from all construction traffic.
   3. Avoid the use of non-vented plastic or canvas shelters which could create a humidity chamber. If cardboard wrapper on doors becomes wet, remove the carton immediately.

4. Provide a 1/4 inch space between stacked doors to promote air circulation. Keep doors and frames dry and clean. Immediately clean and dry doors and frames which become wet or soiled in any way.

1.07 SCHEDULING

A. Coordinate with other work by furnishing Working Drawings, inserts and similar items at the appropriate times for proper sequencing of construction without delays.

B. Do not install doors and frames until all work of this and other Contracts that could damage doors and frames has been completed.

C. Provide temporary doors until construction sequencing allows installation of permanent doors without qualification of acceptable work by Contractor.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Curries by Assa Abloy.

B. Superior Fireproof Door

C. Overly Manufacturing Co.

D. Pioneer Industries

2.02 STAINLESS STEEL DOORS

A. Materials
   1. Doors shall be of the finest commercial quality No. 16 gauge ASTM A167 Type 316 stainless steel, 1-3/4-inch thick, of sizes shown. Doors shall be series "CM" seamless as manufactured by Pioneer Industries, or approved equal.
   2. Finish of all doors and frames shall be #4 finish.
   3. All doors shall be provided with stainless steel tags, 1/2-inch diameter x 1/16-inch thick, stamped with the door number and black Japan-filled; numbers shall conform to those in the Door Schedule.
   4. Glass for all doors shall be secured with 20 gauge moldings of stainless steel fastened with stainless steel counter-sunk flat head machine screws. The moldings shall be assembled as for frames with corners welded and finished to match door material. Doors with glass shall accommodate all unit glazing requirements in accordance with Section 08800 – Glass, Plastic and Glazing.

B. Construction
   1. Core Construction: Manufacturer's standard polystyrene, polyurethane, mineral core, or vertical steel-stiffener core.
      a. Polystyrene and Polyurethane Core: Manufacturer's standard polystyrene or polyurethane core permanently bonded to both faces.

b. Standard Vertical Steel-Stiffener Core: Minimum 22 gage steel-stiffeners at 6 inches on-center.
c. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

2. There shall be no seams on the faces or edges of the doors. Vertical edges shall be continuously heli-arc welded, full height of the door. Exterior doors shall be capped to prevent moisture penetrating the door.
3. Double doors shall have applied stainless steel astragals, 1/8-inch x 1- 1/2- inch.
4. Heads and jambs of frames shall be matched, mitered, welded and finished to present a smooth surface for finishing. Provide a minimum of 3 anchors per jamb, as well as clip angle for floor anchorage. Prepare frames for all hardware at factory from templates furnished. All hardware cutouts shall be reinforced with 1/8-inch plate welded to frame; 3/16-inch plate shall be used for hinge reinforcements.
5. Jambs shall be constructed to be set on the finished floor. Rubber mutes shall be shipped attached to lock jambs on single doors and on head members for double doors.
6. Glass for all doors shall be secured with mouldings of No. 20 gauge stainless steel fastened with stainless steel counter-sunk oval head machine screws. The mouldings shall be assembled as frames with corners welded.
7. All exterior doors shall be fully weatherstripped, as called for under Section 08710.
8. All exterior doors shall be insulated:
   a. Door Core Material: Manufacturers standard core material and construction in compliance with specified requirements.
      1) Thermal Resistance: R-value of 4.75 minimum.
      2) Foam Plastic Insulation: Manufacturer's standard board insulation with maximum flame spread index (FSI) of 75, and maximum smoke developed index (SDI) of 450 in accordance with ASTM E84, and completely enclosed within interior of door.
9. Proper concealed reinforcements of sheet or bar steel shall be provided for hardware and for all attached work. Reinforcement for butt side of doors shall be a continuous 3/16-inch stainless steel plate. Lock reinforcement shall be No. 12 gauge stainless steel sheet. Reinforcement for door closures, holders, checks and brackets shall be No. 12 gauge plate of length as required for finish hardware.
10. Reinforce tops and bottoms of door with minimum No. 16 gauge horizontal stainless steel closing channels, as integral part of door construction, welded continuously to the outer sheets. Close top and bottom edges to provide weatherseal, using 16 gauge flush-mounted inverted closure channels continuously adhered to face sheets with structural silicone adhesive.
11. Edge profiles shall be provided on both stiles of doors beveled 1/8 inch in 2 inches.

2.03 STAINLESS STEEL FRAMES

A. Materials shall be free from defects impairing strength, durability, and/or pressed as required for their respective function. Molded work shall have sharply defined profiles and arises, be clean and sharp. Work shall be of proper dimensions to receive work of others. The indicated and specified thicknesses of the metal are minimum.

B. Provide frames of the type and profile indicated, not less than thickness indicated; to comply with ANSI/SDI A250.8.

C. Gauges for steel used in the work shall be as follows:
   1. Combination Metal Frames and Trim:
      a. Exterior Combination Frames & Trim - 12 gauge.
      b. Interior Combination Frames & Trim - 16 gauge.
      c. Interior Combination Frames & Trim for Fire Rated Frames - 14 gauge.
      d. Exterior Scribe Moulding - 14 gauge.
      e. Interior Scribe Moulding - 18 gauge.
      f. Exterior and Interior Angle Floor Knees, Adjustable Anchors, Slides and Adjustable Anchors - 16 gauge.
      g. Fillers - As required.
   2. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.
   3. Hardware Reinforcement:
      a. Butts, Checks, Overhead Door Holders, Bracking Pulls - 3/16-inch thick.
      b. Locking Latches - 12 gauge.
   4. Trim - 16 gauge.

2.04 STAINLESS STEEL COMBINATION FRAMES AND TRIM

A. Stainless steel combination frames and trim shall be placed at door openings, as shown on the Contract Drawings.

B. Stainless steel combination frames and trim shall be of size and approximate design shown on the Contract Drawings, have integrally molded trim and loose molds according to contours of details, reinforced, drilled tapped for hardware. The type, as detailed, covers the general run of frames for the work but the forming shall be varied from that shown where indicted by special details or necessitated by other conditions.

C. Miter corners accurately, heliarc weld, and dress exposed joints to render same inconspicuous. Spreaders shall be of an approved type.

D. Frames shall extend to rough concrete slab, bottoms provided with suitable angle clips for securing to jambs. Heads of frames for openings wider than 3 feet shall be reinforced with angles or channels formed of No. 10 gauge stainless steel spot welded. Where waterproofing occurs, frames shall extend 1 inch below finished floor. Where required to receive labeled ratings, frames shall be fabricated of gauges required and shall be provided with the necessary labels.

1. Provide stainless steel labels permanently attached to section of frame concealed by closed door.

E. Slots shall be provided at upper sections of vertical members for securing temporary wood blocking to which shall be nailed the braces for holding jambs in place while building walls. All doors frames shall be provided with rubber door silencers, not less than two (2) per jamb.
   1. Rubber door silencers shall be shipped attached to lock jamb on single doors and on head members for double doors.

F. Provide holes as approved for fastening wood blocking and trim where such are required by the Drawings.

G. Finish for stainless steel frames shall be No. 4 Finish.

2.05 ANCHORS FOR STAINLESS STEEL FRAMES

A. Door frames in concrete openings shall be anchored with 4 hex head stainless steel expansion bolts for each jamb and two hex head stainless steel expansion bolts for each head; where steel lintels occur, machine bolts shall be used. Removable stops shall be installed to cover the bolt heads, the stops to be fastened with counter sunk oval head screws.

B. Door frames in brick or hollow tile openings shall have adjustable anchors spaced 12 inches from the top and bottom of rough bucks and intermediate anchors shall be spaced not more then 30 inches apart on each side. Anchors shall slide on a No. 14 ga. 6-inch long steel strap securely welded to rough bucks. The leg extending into the wall shall be crimped No. 14 ga. steel at least 8 inches long where possible and 3 inches wide, except that the width shall not exceed the thickness of the masonry, nor shall the edge of the anchor come closer than 1/2 inch to the finished face of a wall.

C. Door frames in gypsum wall board partition walls shall be provided with welded- in steel anchors, which shall be screw-adjusted after the frame is installed, positioning the jambs solidly against wall structure.

2.06 FABRICATION AND WORKMANSHIP

A. All metal work shall be accurately fabricated and neatly assembled so as to be free from dents, tool marks, warpage, buckle or open joints. All lines shall be straight and true to curvatures as required, arises and angles as sharp as practical, moldings true to profile, miters formed in true alignment and abutting profiles shall intersect accurately.

B. Molded members and moldings shall be as shown on the Contract Drawings, unless otherwise approved. Stock moulding shall be as shown on the Contract Drawings unless otherwise approved. Stock moldings which closely approximate the contours shown on the Contract Drawings will be accepted.

C. All items of template hardware, drilling and tapping shall be located by templates so that accurate alignment will be secured. Templates should be located before manufacturing is commenced.

D. All members shall be accurately fastened together so as to provide rigid construction in the assembled work. Removable members shall be secured with countersunk head tamperproof machine screws not more than 12 inches apart. All connections, except those of removable members shall be welded or interlocked.

E. All exposed face joints between members shall be continuously welded and dressed smooth and flush to be practically invisible.

F. Sinkages, cutouts and concealed reinforcement shall be provided as required for the proper installation and attachment of all hardware.

G. Sinkages shall be provided for butts lock fronts and strikes so that the exposed surfaces of hardware will finish flush with adjacent surfaces.

H. Stainless Steel Doors:
   1. Glazed Lites: Minimum 16 gage (0.8 mm) thick, fabricated from same material as door face sheet in which they are installed.
   2. Astragals: Provide overlapping astragals on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted.
   3. Continuous Hinge Reinforcement: Provide per hinge manufacturer’s template.

I. Stainless Steel Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
   1. Welded Frames: Full depth continuously weld frame seams; grind, fill, dress, and make smooth and flush.
      a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.
   2. High Frequency Hinge Reinforcement: Provide 12 gage angle reinforcements for butt type hinges on every door and frame assembly.
   3. Continuous Hinge Reinforcement: Provide welded continuous 12 gage straps for continuous hinges specified in hardware sets in Division 08 Section, "Door Hardware".
   4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
   5. Jamb Anchors: Provide number and spacing of anchors as follows:
      a. Masonry and Stud Wall Types: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

1) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 84 inches (2137 mm) high.

J. Surface Hardware Preparation: Factory prepare stainless steel work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section, "Door Hardware."
   1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
   2. Reinforce doors and frames to receive non-template, mortised and surface-mounted door hardware.
   3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of stainless steel work for hardware.
   4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

K. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricators shop.
   1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of stainless steel work.
   2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so glazed lites are capable of being removed independently.
   3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

2.07 LABELED WORK

A. Door openings to receive fire ratings as indicated on the Contract Drawings shall have frames and doors and equipment of gauges meeting the requirements for the rating noted. Frames and doors shall bear the necessary label and shall be labeled separately.

B. Each labeled door and frame shall be cut and reinforced to receive the type hardware required.

2.08 HARDWARE

A. Furnish and apply, in connection with this work, all hardware not requiring special finish such as screws, anchors, braces, bolts, etc., as required to erect this work properly.

B. Finishing hardware will be furnished under another Section. This Contractor shall, however, receive, check, store and apply the finishing hardware insofar as it occurs in connection with work under this Section. Protect door knobs by covering with cloth pads securely wired in place and do not apply escutcheons and other trim until directed to do so, by the Engineer.

C. Specified manufacturer's supplemental and special reinforcement for hinges, surface applied closers, holders, coordinators, stops and strikes shall be manufacturer's standard but not less than specified and recommended for maximum heavy-duty construction.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. General Contractor to verify the accuracy of dimensions given to door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded stainless steel frames for squareness, alignment, twist, and plumbness.

C. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

3.03 INSTALLATION

A. Fixed units shall be securely fastened in place and operative units adjusted to work properly.

B. Combination frames and trim shall be securely anchored in place with jambs filled solidly with mortar.

C. Do all necessary cutting, drilling and fitting for securing work in position including all necessary cutting, drilling and tapping of the work to accommodate the work of other trades. Drilling and tapping for non-template hardware shall be performed at the site.

D. Stainless Steel Frames: Install stainless steel frames of size and profile indicated. Comply with ANSI/SDI A250.11.
   1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
      a. At fire-protection-rated openings, install frames according to NFPA 80.

b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
c. Install frames with removable glazing stops located on secure side of opening.
d. Install door silencers in frames before grouting.

2. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with appropriate mortar .
3. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.

3.04 PROTECTION AND CLEANING

A. The Contractor shall provide protection against stains, dirt or damage to the finished installation. The doors shall be adjusted at installation for proper operation. At conclusion of construction, doors shall have any final adjustments made in order to place the doors in perfect operating condition.

B. Upon completion of the project all finished work of this Section shall be carefully cleaned. Defective finish shall be removed and refinished, and all work left clean and perfect.

+ + END OF SECTION + +

SECTION 08311

ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Airtight/Watertight Access Doors.

1.03 REFERENCES

A. ASTM E 152 - Standard Methods of Fire Tests of Door Assemblies

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.

C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

D. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.

E. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).

F. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2016).

G. NFPA 288 - Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance-Rated Assemblies; 2022.

H. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.

I. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. Section 01300 - SUBMITTALS: Procedure for submittals.

B. Shop drawings: Fully describe and locate all items being furnished and include large scale details of principal construction features and internal reinforcement. Indicate dimensions, elevations, hardware, reinforcement, anchor types and spacing, and finishes.

C. Product Data: Indicate door and frame configuration and finishes with manufacturer's standard details and catalog data demonstrating compliance with referenced standards

D. Samples: For each door face material, at least 3 by 5 inches (75 by 125 mm) in size, in specified finish.

E. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

1.05 QUALITY ASSURANCE

A. Manufacturer: Minimum five years documented experience producing products specified in this section.

B. Installer: Minimum five years documented experience installing products specified in this section.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
   2. NFPA 288 for fire-rated access door assemblies installed horizontally.

B. Airtight/ Watertight Access Doors and Frames: Units shall be tested in accordance with the following ASTM Test Methods and found to comply with the test requirements with written certifications provided to the Architect.
   1. Air Infiltration: Less than 0.01 cfm/sq. ft. as tested in accordance with ASTM E283.
   2. Water Penetration: no leakage at 15.05 psf as tested in accordance with ASTM E331.

2.02 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
   1. Acudor Products, Inc.

2. Best Access Doors.
3. J. L. Industries, Inc.; Div. of Activar Construction Products Group.
4. Karp Associates, Inc.
5. Milcor Inc.
6. Nystrom, Inc.

B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

C. Flush Airtight/Watertight Access Doors with Exposed Flanges:
1. Assembly Description: 2 inch deep Fully welded Stainless Steel Frame to prevent leakage with a continuous gasket bulb trim seal and corner mounting clips. Fabricate door to fit flush to frame and seal to gasket. Provide manufacturer's standard-width exposed flange, proportional to door size.
2. Fasteners: Phillips Head Stainless Steel Screw or expansion anchors as required by adjacent construction.
3. Gasket: Continuous Bulb Trim Seal.
4. Locations: Ceiling.
5. Stainless Steel Sheet for Door: 0.054 inch, 16 gauge stainless steel sheet thickness.
   a. Finish: #4 stainless steel with grain running perpendicular to floor plane.
6. Hinges: continuous exposed stainless steel piano hinge.
7. Hardware: Latch with Screw driver slot for quarter turn cam lock unit..
8. Size(s): As indicated on the drawings.
9. Model: ADWT as manufactured by Acudor, Tel.: 800.722.0501 or Architect Approved Equivalent.

D. Hardware:
1. Latch: Self-latching bolt operated by flush key with interior release or as indicated for each door.

E. Locks:
1. Cylinder locks keyed alike for each door panel. Provide 2 keys per access panel. Coordinate locks and keying with the Owner's requirements and existing keying system(s) where applicable.

2.03 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Stainless Steel: Type 304, brushed #4 finish.

C. Frame Anchors: Same type as door face.

D. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F 2329. At stainless steel doors, provide stainless steel fasteners.

2.04 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
   1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
   2. Provide mounting holes in frames for attachment of units to metal or wood framing.
   3. Provide mounting holes in frame for attachment of masonry anchors.

2.05 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Verify that field measurements, surfaces, substrates and project conditions are as required and suitable for installation. Verify that rough openings for door and frame are correctly sized and located. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

D. Secure rigidly in place.

E. Position unit to provide convenient access to concealed work requiring access.

3.03 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

+ + END OF SECTION + +

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SECTION 08331

INSULATED OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Agreement, including General Conditions and Division 01 of the Project Manual, apply to work in this Section.

1.02 SUMMARY

A. This Section includes Motor-operated, Insulated, Fire-rated, Auto-closing, and Windstorm Resistant, Coiling Overhead Door (Rolling Service Door).

B. Related Sections include the following:
   1. Section 05500 - Metal Fabrications.
   2. Division 16 - Electrical for power and controls connections, and fire alarm connections.

1.03 STANDARDS

A. All work of this section shall conform to industry standards and/or manufacturer's recommendations.

B. ASTM International (ASTM):
   1. ASTM A 240 - "Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications".
   2. ASTM A 276 - "Standard Specification for Stainless Steel Bars and Shapes".
   3. ASTM A 312 - "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes".
   4. ASTM C665 - "Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing".
   5. ASTM E84 - "Standard Test Method for Surface Burning Characteristics of Building Materials".
   6. ASTM D 4549 - "Standard Specification for Polystyrene and Rubber-Modified Polystyrene Molding and Extruding Materials (PS)".
   7. ASTM E330 - "Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference".

C. American Society of Civil Engineers / Structural Engineering Institute (ASCE/SEI)
   1. ASCE/SEI 7 - "Minimum Design Loads and Associated Criteria for Buildings and Other Structures".

1.04 PERFORMANCE REQUIREMENTS

A. Successfully tested by Architectural Testing Institute (ATI) under Dade County protocols PA 201, PA 202, and PA 203 for design load of 65.5 PSF.

B. Provide door with Underwriter's Laboratories, Inc. (UL) and Underwriter's Laboratories of Canada (ULC) label for the fire rating classification 1 1/2 hr UL and ULC approved door to be in accordance with both fire and windstorm resistant standards.

C. Design door to withstand a windload of 60 psf, 1.5 safety rating.

D. Manufacturer must be capable of providing certified Net Vertical and Net Horizontal reaction forces imposed on door jambs.

E. Cycle life: Design door of standard construction for normal use of 20,000 cycles.

F. Automatically resettable drop out mechanism with optional release devices. (For manually resettable doors see specs for Fire-Storm® .)

G. Door shall be fully spring-balanced.

1.05 SUBMITTALS

A. Pursuant to Section 01300 - Submittals.

B. Pursuant to Section 01660 - Quality Control.

C. Product Data: Manufacturer’s technical data sheets on each product to be used, including:
   1. Product Literature.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods.

D. Shop Drawings:
   1. Provide shop drawings indicating guide details, head and jamb conditions, spring shafts, anchorage, accessories, hood details, patterns and textures, location and size of lites, operator mounts and other related information.

E. Certifications:
   1. Submit manufacturer’s certificate that products meet or exceed specified requirements.

F. Warranty: Submit sample warranty for coiling overhead door.

G. Door Installer: Submit qualifications for door installer indicating the installer meets the following requirements:
   1. Authorized Installer.

2. Years of experience.
3. Emergency Service.
4. Travel time to project.

H. Closeout Submittals:
1. Maintenance and Operating Manuals: Furnish complete manuals describing the materials, devices and procedures to be followed in operating and maintaining doors under this section. Include parts lists and recommended service intervals.
2. Warranties as specified in this Section.

1.06 QUALITY ASSURANCE

A. Experienced workers familiar with the work and trained according to manufacturer's recommendations and/or industry standards shall perform all work of this section.

B. Fire-Rated Assemblies: Provide door with fire resistance rating required to comply with governing regulations which are inspected, tested, listed and labeled by UL, complying with NFPA 80 for class of opening . Provide UL label permanently fasted to each fire door assembly. Door shall be tested under UL10B and ULC10B, and provided with a 1 1/2 hr. rating. Also Factory Mutual and NY MEA approved.

C. Single-Source Responsibility: Manufacturer shall provide door, tracks, motors, and accessories for each type of door. Secondary components shall come from a source acceptable to the manufacturer of the primary components.

D. Door Installer must be an authorized distributor and maintenance provider of the manufacturer of the doors and operators, to be assured of accessibility to parts, updated product changes, recalls and warranty claims.
1. Maintenance Proximity: Not more than two hours' normal travel time from installer's place of business to project site.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials of this section in manufacturer's original packaging, labeled to show name, brand and type. Store materials in protected dry location off the ground or concrete floor in accordance with manufacturer's instructions.

1.08 WARRANTY

A. Manufacturer's Warranty for Overhead Coiling Door:
1. Overhead coiling door and its component parts for two (2) years from Date of Substantial Completion against defects in material and workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Alpine Overhead Doors, Inc., 8 Hulse Road, Suite 1S, East Setauket, NY 11733. Phone: (800) 257-4634. (Basis of Specification)
   1. Model: Auto Fire-Storm IMB® Insulated Windstorm Resistant Rolling Fire Door.

B. Architect Approved Equivalent that meets or exceeds all requirements of this specification.

2.02 COILING OVERHEAD DOOR

A. Door:
   1. Provide electrically operated, insulated, all stainless steel construction, wind storm resistant overhead coiling door.
   2. Structural Performance Requirements:
      a. Wind Loads: Uniform pressure of 65.5 PSF.
      b. Testing: According to ASTM E330/E330M.
      c. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
      d. Operability under Wind Load: Design overhead coiling doors to remain operable under design wind load, acting inward and outward.
   3. Seismic Performance: Overhead coiling door shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      a. Component Importance Factor: 1.25.

B. Curtain: Interlocking roll-formed slats as specified below. Endlocks shall be attached to each slat to prevent lateral movement.
   1. 7/8" thick interlocking roll formed, insulated metal backed (IMB) V7 slats.
   2. Material:
      a. ASTM 240 Stainless Steel 304 Series.
   3. Finish:
      a. Slat: #4 Satin finish.
      b. Back Cover: #2B Mill finish.
   4. Slat Gauge: 22/22.

C. Insulation: Flame retardant mineral fiber and acoustical dampening insulation, ASTM C 665. Surface Burning Characteristics (per ASTM E 84 and UL 723).
   1. Thickness: 7/8" minimum.
   2. R-Value: 8.0 minimum.

D. Bottom Bar: Two angles, minimum 2 inches by 2 inches by 1/8 inch with single-contact type rubber bottom astragal.
   1. Material:

a. Roll-formed stainless steel angles.
2. Finish:
a. Roll-formed stainless steel angles to be #4 satin finish.

E. Guide Assemblies: Three structural angles, thermal break required, and fitted with removable curtain stops. Size as determined by wind load requirements and door size.
1. Material:
a. ASTM A276 Stainless Steel 300 Series.
b. Finish: Stainless Steel ASTM A304 Mill Finish with insulated fire guide brush seal.

F. Counterbalance Assembly: Torsion
1. Counterbalance assembly: Steel pipe barrel of a size capable of caring a curtain load with a maximum deflection of 0.03" per foot of door width. Heat-treated helical torsion springs encased in a steel pipe and designed to include an overload factor of 25% to ensure minimum effort to operate. Sealed and prelubricated high speed ball bearing at rotating support points. Torsion spring charge wheel for applying spring torque and for future adjustments.
a. Material:
1) ASTM A312 Stainless Steel 300 Series.
(a) Finish: Mill finish.
2) Life Cycle: High Cycle springs designed to satisfy 20,000 life cycles.

G. Hood:
1. 24 gauge stainless steel. Formed to fit the contour of the end brackets with reinforced top and bottom edges. Provide minimum 1/4" fire door internal hood supports.
2. Shape: Hexagon profile, flange up.
3. Material:
a. ASTM A240 Stainless Steel 300 Series:
1) Finish: Mill finish #2B.
4. Hood Baffle: Provide hood baffle with a rubber seal to inhibit air infiltration through hood cavity.

H. Hardware:
1. All miscellaneous hardware shall be stainless steel.

2.03 OPERATION

A. Electric Door Operator:
1. Redi-Reset® Industrial Duty Fire Door Operator, automatic closing motor.
a. Provide motor bracket.

B. Motor Operator:
1. Model Redi-Reset® FGH W/AR-C Release Device to Tie Door to Existing Smoke/Fire Alarm.

a. UL listed and FM approved.
b. NEMA 1 enclosure rating.
c. Horsepower: 1 HP.
d. Phase Service: 208/230V, 3PH, 60HZ.
e. Reducer: Planetary reduction gearing and rotary limit switches.
f. Emergency Operation: Standard auxiliary chain hoist.
g. Removable electrical control panel.
h. Sensing Edge: Monitored Photo Eyes W Electric 2-Wire Non-Monitored Sensing Edge with Coil Cord.
i. Automatic Closure shall be activated by local smoke/fire detector by fire alarm sub-contractor. A release device is required. When automatic closure is activated, electric sensing edge and push button are inoperable.
j. Average closing speed: No less than 6" per second or more than 9" per second.
k. Resetting of spring tension or mechanical dropouts shall not be required. After correction cause of closure, doors shall immediately reset by opening with the push button.
l. No Fail-safe feature: Door will not close automatically during power failure. Prevents unwanted closure during brief outages.
m. Fire door shall be designed so that it may be drop tested by removing the fusible link or activating alarm/smoke detector.
n. Include NEMA 4 Open/Close/Stop Push-Button Station , surface mounted on right hand side of door.

2.04 MOUNTING

A. Interior face mounted on prepared opening.
   1. Header Weatherseal: Provide a “Z” shape brush seal to inhibit air infiltration between the header and the curtain.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared. Verify that site conditions are acceptable for installation of doors, operators, controls and accessories. Ensure that openings are square, flush and plumb.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. General: Install door, guides and operating equipment complete with all necessary accessories and hardware according to Shop Drawings and manufacturer's instructions.

B. Lubricate bearings and sliding parts, assure weather tight fit around door perimeter and adjust doors for proper operation, balance, clearance and similar requirements.

C. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

3.04 PROTECTION

A. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance. Remove and legally dispose of construction debris from project site.

B. Remove temporary coverings and protection of adjacent work areas. Repair or replace installed products damaged prior to or during installation.

C. Protect installed products until completion of project.

D. Touch-up, repair or replace damaged products before Substantial Completion.

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: At Owner's request, provide manufacturer's filed service consisting of product installation and use recommendations, and periodic site visits to observe and ensure product installation is done in accordance with manufacturer's recommendations.

3.06 FIELD TESTING

A. Test door for regular operation and automatic closing. Proper authorities having jurisdiction must witness test and sign Drop Test Form.

3.07 DEMONSTRATION

A. Instruct the Owner's personnel in correct operation and maintenance of units.

+ + END OF SECTION + +

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SECTION 08340

FIBERGLASS REINFORCED PLASTIC DOORS AND FRAMES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install doors and frames as shown and specified.
   2. The extent of doors and frames Work is shown on the Drawings.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed or demolished in association with the doors and frames.

C. Related Sections:
   1. Section 04201, Unit Masonry Construction.
   2. Section 04220, Concrete Unit Masonry.
   3. Section 07920, Joint Sealants.
   4. Section 08710, Door Hardware.
   5. Section 08800, Glass and Glazing.

1.02 QUALITY ASSURANCE

A. Reference Standards: Comply with the latest edition of the applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ANSI A115, Specifications for Door and Frame Preparations for Hardware.
   2. ASTM A 103, Zinc (hot-galvanized) Coatings on Products Fabricated From Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
   3. ASTM A 123, Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
   4. ASTM B 509, Cellular Elastomeric Preformed Gasket and Sealing Material.
   5. ASTM D 2000, Classification for Elastomeric Materials for Automotive Applications.
   6. Underwriters laboratories, Inc. “Standard for Fire Test of Doors, UL10B”.
   7. ASTM D 635, Standard Test Method for Rate of Burning or Extent and Time of Burning of Self Supporting Plastics in a Horizontal Position.
   8. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   9. ASTM D 2287, Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.

10. NAAMM, Entrance Manual.
11. Laminate properties:
    a. ASTM D 882 Tensile strength.
    b. ASTM D 790 Flexural strength.
    c. ASTM D 2583 Barcol Hardness.
    d. ASTM D 256 Impact resistance.
    e. ASTM D 792 Density/specific gravity of laminate.
12. Core Properties
    a. ASTM C 177 Thermal properties.
    b. ASTM D 1622 Density/specific gravity.
    c. ASTM D E 84 Surface burning characteristics.

B. Manufacturer Qualifications: Provide doors and frames manufactured by a single firm specializing in the production of this type of Work.

C. Referenced Standard: Where labeled fire doors are required, Fiberglass Doors and frames shall be UL listed and shall be tested successfully to UL10B / UL10C, UBC 7-2 standards.

1.03 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Product Data: Manufacturer's printed product data indicating characteristics of products specified in this Section.
2. Plans: Indicate location of each door opening assembly in project.
3. Elevations: Dimensioned elevation of each type door opening assembly in project; indicate sizes and locations of door hardware, and lites and louvers, if specified.
4. Details: Installation details of each type installation condition in project; indicate installation details of glazing, if specified.
5. Schedule: Indicate each door opening assembly in project; cross-reference to plans, elevations, and details.

B. Selection Samples: Manufacturer's standard color chips.

C. Verification Samples: Two (2) samples to verify color match.

D. Manufacturer's Instructions: Printed installation instructions for door opening assemblies.

E. Warranty Documents: Manufacturer's standard warranty documents, executed by manufacturer's representative, countersigned by Contractor.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Package door opening assemblies in manufacturer's standard containers.

B. Storage of Materials:
   1. Store door assemblies in manufacturer's standard containers, on end, to prevent damage to face corners and edges.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Fiberglass Met: Random glass fiber mat. Minimum 4.5 ounces per square foot weight of glass material.

B. Anchors: Manufacturer's standard stainless steel fasteners.

C. Bonding Materials: Manufacturer's standard frame-to-opening bonding system.

D. Joint Sealer: Sealant, specified in Section 07920.

2.02 FABRICATION

A. General:
   1. Sizes and Profiles: The required sizes for door and frame units, and the profile requirements are shown on the Drawings. Variable dimensions for profiles (if any) are shown along with maximum and minimum dimensions as required to achieve design requirements and coordination with other work.
   2. The details shown are based upon standard details by one or more manufacturers. Similar details by other manufacturers will be acceptable, provided they comply with the size requirements, and with minimum/maximum profile requirements as shown.

2.03 HARDWARE

A. Flush Doors: Refer to Section 08710, Door Hardware, and to the frame, door and hardware schedules and details, for the furnishing and installing of hardware items.

B. Hardware Installation: Cut, reinforce, drill and tap frames and doors as required to receive hardware, except do not drill and tap for surface mounted items until the time of installation. Comply with hardware manufacturer's instructions and template requirements. Use concealed, stainless steel fasteners wherever possible.

2.04 MANUFACTURED UNITS

A. Fire-rated Fiberglass Reinforced Plastic (FRP) Doors:
   1. Construction.
      a. Door Thickness.
         1) 1-7/8" at door edge.
      b. Stiles.
         1) Single Swing.
            (a) Hinge and lock stile, 2" minimum tectonite.

2) Standard Pairs.
(a) Hinge stile, 2” minimum tectonite.
(b) Meeting edge, 3” minimum.

c. Rails.
1) Top rail, 6” minimum tectonite.
2) Bottom rail, 4” minimum for single swing, 4-1/2” minimum for pairs tectonite.

d. Core.
1) Fire rated mineral core.
2) 1-1/2” nominal thickness.
3) 18 pcf minimum density.

e. Face Sheet.
1) Exterior
(a) 0.120” thick, pebble texture, through color with integral surfaseal film FRP sheet.
(b) Optional painted finish consult manufacturer.
(c) Class C standard.
2) Interior
(a) 0.120” thick, pebble texture, through color with SpecLite 3® integral surfaseal film FRP sheet.
(b) Optional painted finish consult manufacturer.
(c) Class C standard optional Class A available consult manufacturer.

f. Edge Channels.
1) 0.062” thick, 3/4” leg, stainless steel edge channel.
2) Applied to entire perimeter of the door.
3) Sealed by 3M CP 25WB + Fire Barrier caulk applied to the inside edges of all the steel edge channels.

g. Cutouts.
1) Manufacture doors with cutouts for required vision lites per the manufactures listing.

h. Fire Rating: as noted on drawings.

i. Size: as noted on drawings.

B. Fire Rated FRP Frames:
1. Materials.
a. ¼” thick, solid, pultruded, FRP profiles.
b. No corrosive components or reinforcements.
c. Solid tectonite filler.
d. No steel or aluminum filler is allowed.
2. Perimeter Frame Members.
a. Factory fabricated.
b. Integral 5/8” x 2-1/4” doorstop.
c. Mitered with 4” x 4” x 3/8” pultruded FRP angle reinforcement with interlocking pultruded FRP brackets.

d. 5-3/8” jamb depth.
e. 2” face on jambs.
f. 2” or 4” face on header.
g. Knocked down for field assembly.

3. Anchors
   a. Factory furnished as specified by drawings.

C. Product and Manufacturer: Provide one of the following:
1. Fiberglass Reinforced Plastic door and frames by Special Lite.
2. Fiberglass Reinforced Plastic door and frames by Chem-Pruf Door Company.
3. Fiberglass Reinforced Plastic door and frames by Tiger Door FRP an Overly Door Company

2.05 FABRICATION

A. Fiberglass Reinforced Plastic (FRP) Doors: Workmanship is to be of the highest quality in order to meet quality control requirements.
1. Stile and Rail Structure:
   a. Form in mold of exact door size, with get coat layer to form, glass mat layers to a U-shaped channel interior.
   b. Formulate get coat for environment and integral color specified.
   c. Form structure as single component, jointed construction at intersections of stiles and rails is prohibited.
   d. Form mortise for lockset, and recess for strike plate in lock stile, at time of molding.
   e. Embed compression members at the time of molding in locations where thru-bolting of hardware is required.
2. Core:
   a. Fit core material within stile/rail structure, fit around compression members and projections of mortises.
   b. Mold openings for lites or louvers, if specified, form to sizes and at locations indicated.
3. Face sheets:
   a. Formulate get coat with integral color specified, embed glass materials.
   b. Chemically bond face sheets to stile/rail structure and core material.

B. Fiberglass Frames:
1. Resin transfer in mold of exact wall opening size, with get coat. Glass mat layers to form solid fiberglass outer surface.
2. Formulate get coat for environment and integral color specified.
3. Form structure of fiberglass components.
4. Form mortise for kick strike, and recess for strike plate in lock jamb, at time of molding.
5. Embed reinforcement for hinges and other indicated hardware in fiberglass matrix, provide for hinge leaf recesses in hinge jamb at time of molding.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor and his installer must examine the substrate and conditions under which doors and frames Work are to be installed and notify the Engineer in writing of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.02 INSTALLATION

A. Install door opening assemblies in accordance with shop drawings, SDI-100, and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.

B. Installation of door hardware is specified in Section 08710.

C. Install door hardware in accordance with manufacturer's printed instructions, using through-bolts to secure surface applied hardware.

D. Site Tolerances: Maintain plumb and level tolerances specified in manufacturer's printed installation instructions.

3.03 CLEANING AND REPAIRING

A. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding, and to remain in place at any angle without being moved by gravitational influence.

B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

C. Clean surfaces of door opening assemblies and sight-exposed door hardware in accordance with manufacturer's maintenance instructions.

D. Protect door opening assemblies and door hardware from damage by subsequent construction activities until final inspection.

+ + END OF SECTION + +

SECTION 08441

GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

B. Section 08800 - Glass and Glazing.

1.02 SUMMARY

A. Section includes the following: conventionally glazed aluminum curtain walls installed as assemblies.
   1. Conventionally glazed stainless steel clad curtain walls installed as assemblies.
   2. Stainless Steel clad curtain wall framing with wire mesh infill.
   3. Sunscreens attached to and supported by curtain wall framing.
   4. Stainless Steel clad entrance doors in curtain wall framing with glazing or stainless steel mesh as indicated on drawings.

1.03 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by preconstruction testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Glazed aluminum curtain walls shall withstand movements of supporting structure indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   2. Failure also includes the following:
      a. Thermal stresses transferring to building structure.
      b. Glass breakage.
      c. Noise or vibration created by wind and thermal and structural movements.
      d. Loosening or weakening of fasteners, attachments, and other components.
      e. Failure of operating units.

B. Delegated Design: Design curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   1. Design shall include attached sunscreen system.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
    a. Basic Wind Speed: 130 mph.
    b. Risk Category: III
    c. Exposure Category: C.
2. Blast Loads: As indicated on Drawings.
3. Periodic Maintenance-Equipment Loads: As indicated on Drawings.

D. Structural Test Performance: Test according to ASTM E330/E330M as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

E. Deflection of Framing Members: At design wind pressure, as follows, as tested in accordance with ASTM E330:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.
    a. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.
    b. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.
2. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.

F. Windborne-Debris-Impact-Resistance Performance: Pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E1996 for Wind Zone I.
1. Large-Missile Test: For glazed openings located within 30 feet of grade.
2. Small-Missile Test: For glazed openings located more than 30 feet above grade.

G. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
1. Component Resistance Factor: 1.5

H. Story Drift: Accommodate design displacement of adjacent stories indicated.
1. Design Displacement: As indicated on Drawings.
2. Test Performance: Meeting criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement.

I. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (720 Pa). There shall be no water leakage as defined by AAMA 501.1, paragraph 5.5.

J. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (720 Pa).
   1. Maximum Water Leakage: According to AAMA 501.1 No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.

K. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:
   1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
   2. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
   3. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

L. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.
   1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than.24 (Summer - Day).
   2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.35 as determined according to NFRC 200.
   3. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. value of fixed wall area as determined according to ASTM E283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).
   4. Condensation Resistance Factor (CRF): Fixed glazing and framing areas shall have an NFRC- certified condensation resistance rating of no less than 66 as determined according to AAMA 1503.

M. Sound Transmission: Provide glazed aluminum curtain walls with fixed glazing and framing areas having the following sound-transmission characteristics:
   1. Outdoor-Indoor Transmission Class: Minimum 30 when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E1332.
   2. Sound Transmission Class (STC): Minimum 29 when tested to AAMA Specification 1801 and in accordance with ASTM E1425 and ASTM E90.

1.04 PRE-CONSTRUCTION TESTING

A. Preconstruction Testing Service: Provide glazed aluminum curtain walls that comply with test-performance requirements indicated, as evidenced by reports based on Project-specific preconstruction testing by a qualified testing agency.
   1. Owner will engage a qualified testing agency to perform preconstruction testing on laboratory mockups.
   2. Build laboratory mockups at testing agency facility using personnel, materials, and methods of construction that will be used at Project site.
   3. Notify Architect five days in advance of the dates and times when laboratory mockups will be constructed.
   4. Preconstruction Testing Program: Perform tests specified in "Performance Requirements" Article on laboratory mockups in the following order:
      a. Structural-performance preloading at 50 percent of the specified wind-load design pressure when tested according to ASTM E330/E330M.
      b. Air infiltration when tested according to ASTM E283.
      c. Water penetration under static pressure when tested according to ASTM E331.
      d. Water penetration under dynamic pressure when tested according to AAMA 501.1.
      e. Structural performance at design load when tested according to ASTM E330/E330M.
      f. Repeat air filtration when tested according to ASTM E283.
      g. Repeat water penetration under static pressure when tested according to ASTM E 331.
      h. Structural performance at maximum 150 percent of positive and negative wind-load design pressures when tested according to ASTM E330/E330M.
      i. Condensation Resistance Factor (CRF) Test units in accordance with AAMA 1503.1
      j. Thermal Resistance (U-Factor). Test units in accordance with NFRC 500.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
   2. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
      a. Joinery, including concealed welds.
      b. Anchorage.
      c. Expansion provisions.
      d. Glazing and wire mesh infill.

e. Sunscreen attachment.
f. Flashing and drainage.

3. Include laboratory mockup Shop Drawings, prepared by a qualified preconstruction testing agency, showing details of laboratory mockup.
   a. Resubmit Shop Drawings with changes made to glazed aluminum curtain walls to successfully complete preconstruction testing.
4. Submittals for Sunscreen.
   a. Manufacturer's Installation Instructions.
   b. Samples for Verification.
      1) Factory applied finish as selected by architect.
   c. Shop Drawing including:
      1) Plans, elevations, sections, fabrication and installation details.
   d. Provide validation from manufacture of single-source for sunscreens and framing system, compatibility with the curtain wall, and compatible warranty.

C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

D. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300 mm) lengths of full-size components and showing details of the following:
1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

E. Delegated-Design Submittal: For curtain walls and associated components, including but not limited to sunscreens, indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Provide test reports from AAMA accredited laboratories certifying the performance as specified herein. Test reports shall be accompanied by the curtain wall manufacturer's letter of certification stating that the tested curtain wall meets or exceeds the referenced criteria for the appropriate curtain wall type.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Seismic Qualification Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

C. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
   1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified preconstruction testing agency, for glazed aluminum curtain walls, indicating compliance with performance requirements.

E. Field quality-control reports.

F. Warranties: Sample of special warranties.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For curtain walls and associated components to include in maintenance manuals.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating glazed aluminum curtain walls that meet or exceed energy performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

C. Testing Agency Qualifications: Qualified according to ASTM E699 for testing indicated.

D. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

E. Energy Performance Standards: Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
   1. Provide NFRC-certified glazed aluminum curtain walls with an attached label.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Field testing shall be performed on mockups according to requirements in "PRECONSTRUCTION TESTING" Article.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.09 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain walls by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Special Assembly Warranty: Standard form in which manufacturer agrees to repair or replace components of curtain walls that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration created by wind and thermal and structural movements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Water penetration through fixed glazing and framing areas.
      e. Failure of operating components.
   2. Warranty Period: 10 years from date of Substantial Completion.

B. Glass
   1. Provide written warranty for insulated glass units, that they will be free from obstruction of vision as a result of dust or film formation on the internal glass surfaces caused by failure of the hermetic seal due to defects in material and workmanship.
   2. Warranty period shall be for 10 years.

C. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace stainless steel or other finishes that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. EFCO Corporation: EFCO® Series 5600 Outside Glazed.(Basis of Design)
   2. Arcadia Inc. T500 Series (OPG-3000).

3. YKK AP America Inc.

2.02 MATERIALS

A. Aluminum Extrusions: ASTM B221: 6063-T6 alloy and temper or recommended by glazed aluminum curtain wall manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.093 inch to 0.125 inch wall thickness as required design parameters.

B. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   1. Sheet and Plate: ASTM B209 (ASTM B209M).
   2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221 (ASTM B221M).
   3. Extruded Structural Pipe and Tubes: ASTM B429/B429M.
   4. Structural Profiles: ASTM B308/B308M.
   5. Extruded Aluminum: 6063-T6 alloy and temper.

C. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No.12; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
   2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

D. Stainless Steel Cladding and Flashing Sheets and Plates:
   1. Basis-of-Design: MAC Tech Fabrication & Repairs--SS Cladding in Industrial Satin Finish
   2. Custom-fabricated factory roll-formed sheet and plate, Type 316, 20-gauge stainless steel sheet for cladding, 1/8-inch stainless steel plate for other formed stainless-steel components, and custom fabricated factory roll-formed type 316 stainless steel flashing of 14 gauge thickness complying with ASTM A 666 of modular widths shown and of lengths as long as practical to minimize joints. Provide factory corrective-leveled panels.
   3. Provide all cladding and flashing sheets and plates with a uniform, bright, mill-polished surface obtained by finishing with a 150 - 220 mesh abrasive, following initial grinding with coarser abrasives. The finish shall be characterized by very fine parallel “grit lines” and be within a uniform range established as AISI No. 4 or 5 finish, with final finish established by Sample submission as approved by Engineer.
   4. Provide stainless steel sheet cladding, and plate closures and accessories, for exposed items, to comply with the requirements of performance, fabrication, and control of finish.
   5. Provide cladding over exterior portions of curtain wall only. Exterior portions include cover plates and any accessories on the exterior and side of the glazing
   6. Provide sheet free of defects impairing strength, durability, color or finish.

7. Modify cladding in the factory as required for sunscreen attachment and other accommodations as required for a complete installation.
8. No exposed fasteners permitted, stainless steel to be clad with VHB tape.
9. Cladding of aluminum entrance door to be completed to not bridge thermal break.
10. Removable stops on entrance doors must be clad independently to allow glass and or infills to be replaced without full removal of cladding.
11. Manufacturer of cladding for entrance door and curtainwall frames must be done by same source to ensure cladding does not interfere with swing path and weatherability of doors

E. Stainless Steel Wire Mesh:
1. Type 304 stainless steel wire mesh curtain wall infill constructed of .5" x .5" x .063" (12.7mm x 12.7mm x 1.60mm) stainless steel wire mesh with 79% open area minimum, by McNichols or equal, Set into type 304, 14 gauge stainless steel frames sized to fit into glazing channels within curtain wall system frames. Locations shall be as indicated on the contract document elevations drawings.

2.03 FRAMING

A. Framing Members: 2 1/4 inch X Therm 5600 Curtain Wall System manufacturer's standard extruded aluminum framing members of thickness required and reinforced as required to support imposed loads. Tested to AAMA 501 and TAS 202.
1. System Depth: 10 inches minimum.
2. Construction: Thermally broken. Non-thermally broken acceptable where used in exterior spaces.
3. Glazing System: outside glazed, retained mechanically with gaskets on four sides.
4. Glazing Plane: Front.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.
1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.

D. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.

E. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish

compatible with adjoining materials and recommended by manufacturer. All steel anchors shall be properly insulated from the aluminum.

F. Pressure Plate: Pressure plate shall be either aluminum or fiberglass and fastened to the mullion with stainless steel screws. Fiberglass pressure plate shall be tested to ASTM D6938, ASTM D790, ASTM D695, ASTM D953 and ASTM D3846.

G. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

H. Framing Sealants: Manufacturer's standard sealants.

I. Thermal Barrier: Thermal separator shall be extruded PVC used as an applied thermal isolater.

J. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of glazed curtain wall members are nominal and in compliance with AA Aluminum Standards and Data.

2.04 GLAZING

A. Glazing: Comply with Section 08800 - GLASS AND GLAZING.

B. Framing Members: Manufacturer's standard extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Glazing System: 4-sided captured.
   2. Glazing Plane: Front.

C. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers. Gaskets shall meet the requirements of ASTM C864.

D. Glazing Sealants: As recommended by manufacturer for joint type.
   1. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Sealants used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Spacing and Setting Blocks: Manufacturer's standard elastomeric type.

F. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

2.05 OPERABLE UNITS

A. General: Doors shall be fabricated with minimum clearances and shim spacing around perimeter of assembly, however clearance shall be provided to allow for cladding, installation and dynamic movement of perimeter seal. Provide stainless steel doors in accordance with section 08131 - Stainless Steel Doors and Frames. Frames shall conform to the requirements of this section.

B. Materials:
   1. Aluminum: 6063-T6 Alloy and temper as recommended by manufacturer for type of use and finish indicated.
      a. Sheet and Plate: ASTM B209.
      b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
      c. Extruded Structural Pipe and Tubes: ASTM B429/B429M.
      d. Structural Profiles: ASTM B308/B308M.
      e. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
   2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
      a. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
      b. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
      c. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
   3. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.
   4. Stainless Steel Cladding: As indicated elsewhere in this section.
   5. Stainless Steel Wire Mesh Infill: As indicated elsewhere in this section.
   6. Glazing: As indicated in Section 08800 - Glass and Glazing.

C. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
   1. Door Construction: 2 inches overall thickness, with minimum 0.125-inch thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded, items shall not bridge thermal barriers. Thermal barriers shall align at corners.
   2. Corner construction shall be joined by heavy concealed reinforcement brackets with screws and shall be of deep penetration and fillet welded.
   3. Door Design: D502 (5 inch face dimension).
      a. Top Rail: 5 inch (D502).
      b. Bottom Rail: 10 inch

4. Thermally Broken Entrance Framing : 4 1/2 inches deep, thermally broken with a 1/4" (6.4 mm) separation consisting of a two-part chemically curing, high-density polyurethane, which is mechanically and adhesively joined to aluminum storefront sections. Shear Block construction. Door shall be capable of having separate interior ans exterior finishes as indicated or as selected by the Architect.
5. Glazing Stops and Gaskets: Exterior stops shall be a integral part of the door, Interior stops shall be Square, snap-on, extruded-aluminum stops, 0.05" (1.3 mm) thick and preformed gaskets of EPDM elastomeric extrusions or a thermoplastic elastomer.
6. Provide adjustable glass jacks to help center the glass in the door opening.
7. Slide-In-Type Weather Stripping: Provide wool-pile weather stripping installed in one stile of pairs of doors and in jamb stiles of center pivot doors. Comply with AAMA 701/702.
    a. Weather Seals: Provide weather stripping with integral barrier fin or fins of semi-rigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 701/702.

D. Door Hardware: Hardware for doors in curtain wall framing shall be furnished and installed in the doors by the door manufacturer, and shall comply with Section 08710 - Finish Hardware and the following:
    1. Pivot Hinges: BHMA A156.4, Grade 1.
    2. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
    3. Cylinders: As specified in Section 08710 - Door Hardware and coordinated with client master key system.
    4. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
    5. Operating Trim: BHMA A156.6.
    6. Closers: BHMA A156.4, Grade 1, Certified Products Director (CPD) listed surface mounted heavy duty closers.
    7. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.
    8. Weather Stripping: Manufacturer's standard replaceable components.
        a. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing with polymeric fin.
        b. Meeting stiles on pairs of doors shall be equipped with two lines of weather-stripping utilizing wool pile with polymeric fin.
        c. The door weathering on a single acting offset pivot or butt hung door and frame (single or pairs) shall be comprised of a thermoplastic elastomer weathering on a tubular shape with a semi-rigid polymeric backing and a wool pile with polymeric fin.
    9. Weather Sweeps: EPDM blade gasket sweep strip in an aluminum extrusion applied to the interior exposed surface of the bottom rail with concealed fasteners

10. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1v:2h, with maximum height of 1/2 inch. Thermally broken, with ribbed slip-resistant surface.

2.06 INTEGRATED SUNSCREEN

A. General: Provide fixed horizontal sunscreens and accessories of design, material, sizes, depth, arrangement, and thickness as indicated on the contract drawings. Work shall include complete support and attachment to curtain wall framing and/or building structure for optimal performance with respect to strength; durability; and uniform appearance. Include supports, anchorage, and accessories required for complete assembly.
   1. Sunscreens shall be provided by the curtain wall manufacturer or manufacturer approve d sub-contractor to provide an full system integrated warranty.

B. Design sunscreens to accommodate local requirements for snow and wind loading. Provide vendors calculations for the design being supplied. Calculation should be signed and sealed by an Engineer registered in the state where the project is located. Analysis of Blade Deflection to be limited to L/120, ¾", or as required by code.

C. Provide fixed Horizontal Sunscreens as manufactured by the following or approved equal

D. Materials: Extruded aluminum blades and outriggers, designed to integrate with curtain wall framing and associated support system, with gasketed cast aluminum fitting connecting outrigger to through-tube structural supports without flashing and without compromising weather barrier.
   1. Configuration: Fins to be fabricated from two-piece 6063-T5 alloy extrusions and are to be 14" x 2 ¾" airfoil profile blades.
   2. All exposed components to be clad with Type 316, 20-gauge stainless steel with finish to match curtain wall cladding.
   3. Blade fins to be notched around around vertical components as required to provide a continuous appearance.
   4. Blade fins to be mounted with custom end caps and stand-off receiver brackets fixed to curtain wall framing.
   5. Blade fin slope and spacing to be as detailed, or as required in order to provide maximum sun cut-off during the summer months.
   6. All mounting brackets and associated hardware are to be provided by the sunscreen / curtain wall manufacturer.
   7. All fascia, blades, and outrigger components shall be 6063-T5 aluminum alloy.
   8. Thickness and size of sunshade bracket to be determined by stamped engineered calculations.

2.07 ACCESSORY MATERIALS

A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

B. Brackets for light fixture installation: Openings for exterior lighting within the curtainwall and/or stainless steel mesh to be provided by the curtain wall contractor. Opening shall be cut to coordinated size, reinforced with 1.5" stainless bar stock around the perimeter, and welded off-site. Any bracket and/or reinforcing for the light fixture to be provided by curtain wall contractor and fabricated of stainless steel to match curtain wall framing.

2.08 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. All aluminum vertical and horizontal extrusions shall have a minimum wall thickness of 0.093 inch to 0.125 inch.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Frame components shall be mechanically fastened by means of extruded aluminum shear blocks attached to the vertical mullions.
   4. Physical and thermal isolation of glazing from framing members.
   5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   6. Provisions for field replacement of glazing from exterior. Outside glazed curtain wall system shall be dry glazed with an exterior aluminum pressure plate and snap cover with interior and exterior
   7. Provisions for safety railings mounted between mullions at interior.
   8. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   9. Curtain wall system is able to accommodate separate interior and exterior finishes and colors.

D. Fabricate components that, when assembled, have the following characteristics:
   1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
   2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

E. Curtain Wall:

1. Take field measurements, prior to start of Working Drawings and fabrication of curtain wall system components. Do not delay job progress. Allow for erection tolerances corresponding with specified tolerances where final dimensions cannot be established before fabrication.
2. Complete the fabrication and assembly of the curtain wall system at the shop to the greatest extent possible, to minimize field cutting, splicing, fastening, sealing, finishing and similar work. Maintain provisions for expansion and movement as required. Disassemble only as necessary for shipment and erection. Maintain true continuity of line and accurate relation of planes and angles. Provide secure attachment and support at mechanical joints, with hairline fit of contacting members.
3. Provide sizes, shapes and profiles as shown on the Contract Drawings and required to fabricate curtain wall system.
4. Provide mullions as shown on the Contract Drawings, projecting inside the plane of the glass with one exterior pressure plate section per mullion. Attach covers with PVC isolators.
5. Provide mullions fabricated for field connection at intersections, using screws and channel clips furnished by the manufacturer.
6. Complete the cutting, fitting, forming, drilling and grinding of all metal work prior to cleaning, finishing, treatment, and application of coatings.
7. Reinforce the work with structural stainless steel sections as necessary for performance requirements, and for support of the system. Separate dissimilar metals with bituminous paint to prevent corrosion. Separate metal surfaces at moving joints with plastic inserts or other non-abrasive concealed inserts which will permanently prevent "freeze-up" of the joint.
8. Provide curtain wall system capable of accommodating 1-5/8-inch insulating glass, and entry doors as shown on the Contract Drawings. System shall accommodate exterior glazing and reglazing. Provide not less than minimum clearances for thickness and type of glass according to requirements specified in Section 08800.
9. Components shall be fabricated to drain water penetrating joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.
10. Removable screened, Glazed Curtain Wall System shall comply with all requirements and design criteria specified herein with the exception that the complete system including frame, supplemental support system and all appurtenances shall be removable by standard tools without damage to adjoining surfaces. Clear opening shall result from the act of removal. The manufacturer shall include complete instructions on removal and reassembly of removable assemblies. The removable screened, Glazed Curtain Wall System shall reassemble without need for replacement of any component or part of the removable louver assembly. No fasteners shall be visible from the exterior face of the building.

F. Stainless Steel Cladding and Flashing Sheets and Plates:

1. Provide miscellaneous flashings and closures as required to complete the work and as shown on the Contract Drawings and approved Working Drawings.
2. Form shapes with sharp profiles, straight and free of defects or deformation, before finishing.
3. Prepare components to receive concealed fasteners and anchor and connection devices. Exposed fasteners for joining and anchoring stainless steel cladding shall not be approved by Engineer. Blind fastening techniques shall be used for fabrication of all stainless steel cladding and flashing.
4. Joints between sections of stainless steel cladding shall be formed using interlocking butt joints using threaded studs welded to the back of the stainless steel cladding and supported from the aluminum members using low-profile stainless steel zee-clips with finger slots and locking keyhole slots for invisible support and assembly of face sheet cladding.
5. Custom welded transition stainless steel cladding shapes shall be provided at aluminum mullion intersections. Joints in stainless steel cladding at intersecting aluminum mullions shall be shop-fabricated and finished so that first interlocking butt joint occurs at the side faces of intersecting aluminum mullions. Joints positioned at other locations in the Work shall not be approved by Engineer.

G. Welding:
1. Follow recommendations of AWS A5.10, to avoid discoloration at welds. Grind exposed welds smooth and restore mechanical finish. Remove arises from cut edges and ease edges and corners to a radius of approximately 1/64 inch.
2. Weld components to comply with referenced standards and Working Drawings. Weld before finishing components. Weld in concealed locations to the greatest extent possible. Remove all weld spatter and welding oxides from exposed joint surfaces by descaling and grinding. Restore finish to match adjacent surfaces.
3. Capacitor discharge stud welding techniques shall be used to fasten studs to the back of stainless steel cladding and flashing in order to eliminate marring or discoloration of visible side of face sheets.

H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.09 SOURCE QUALITY CONTROL

A. Obtain all curtain wall system components, flashing and accessories from the same manufacturer.

B. Engage a manufacturer who requires that a Technical Representative be present at the start of the work and who requires that the completed work be inspected by a Technical Representative of the curtain wall manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. The Contractor shall examine the supporting structure and other elements of the substrate and conditions under which the curtain wall system is to be performed and notify Engineer in writing of unsatisfactory tolerances which exceed specified limits in other work adjoining curtain wall system, and other conditions detrimental to proper and timely completion of the work. Do not proceed with erection until unsatisfactory conditions have been corrected in a manner accept- able to Engineer.

B. Verify to Engineer gauge of aluminum extrusions, stainless steel cladding, closures and flashing brought to the site by actual measurement of on-site material in the presence of Engineer.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

3.03 INSTALLATION

A. General:
   1. Comply with manufacturer's written instructions.
   2. Do not install damaged components.
   3. Fit joints to produce hairline joints free of burrs and distortion.
   4. Rigidly secure non-movement joints.
   5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
   6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
   7. Seal joints watertight unless otherwise indicated.

B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Provide thermal expansion for running trim, flashings, and other items exposed for more than 15 feet - 0 inches continuous length. Maintain a watertight installation at expansion seams. Locate expansion seams at 10 feet - 0 inch intervals, and 2 feet - 0 inch each side of corners and intersections and at high points of flashing and trim Work.

D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

E. Install components plumb and true in alignment with established lines and grades.

F. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

G. Do not install component parts that are observed to be defective in any way, including warped, bowed, dented, abraded, scratched, gouged and broken members, and including glass with edge damage.

H. Do not cut, or trim, component parts during erection, in a manner which would damage the finish, decrease the strength, or result in a visual imperfection or a failure in performance of the aluminum curtain wall work. Return component parts which require alteration to the shop for refabrication, if possible, or for replacement by new parts.

I. Install glazing as specified in Section 08800 - GLASS AND GLAZING.

3.04 ERECTION TOLERANCES

A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
   1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6 mm in 12 m).
   2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
   3. Alignment:
      a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
      b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
      c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
   4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m); 1/2 inch (12.7 mm) over total length.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of representative areas of glazed aluminum curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.

1. Air Infiltration: Areas shall be tested for air leakage of 0.06 cfm / sq. ft. of fixed wall area when tested according to ASTM E783 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).
    a. Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of glazed aluminum curtain wall.
    b. Perform a minimum of three tests in areas as directed by Architect.
    c. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
2. Water Penetration: Areas shall be tested according to ASTM E1105 at a minimum cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
    a. Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of glazed aluminum curtain wall.
    b. Perform a minimum of three tests in areas as directed by Architect.
    c. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
3. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
    a. Test Area: A minimum area of 45 feet (18 m) by one story of glazed aluminum curtain wall.

C. Curtain walls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.06 ADJUSTING, CLEANING AND PROTECTION

A. Protection: Protect installed product's finish surfaces from damage during construction. Protect aluminum curtain wall system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.

B. Cleaning: Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.

C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period

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SECTION 08710

FINISH HARDWARE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install finish hardware.
   2. Extent of door hardware is specified. Door finish hardware is defined to include all items known commercially as finish hardware, except special types of unique and non-matching hardware specified in the same Section as the door and door frame.
   3. Types of finish hardware required include the following:
      a. Hinges.
      b. Flush bolts and dust proof strikes.
      c. Door closers.
      d. Overhead holders and stops.
      e. Cylinders for doors specified in other Sections.
      f. Coordinators.
      g. Astragals.
      h. Weatherstripping and seals.
      i. Thresholds.
      j. Silencers.
      k. Floor stops.
      l. Wall stops.
      m. Miscellaneous items and accessories for a complete installation functioning in compliance with the requirements of governing authorities having jurisdiction at the Site.
      n. Temporary hardware for temporary protection and/or temporary operation of doors.
   4. Coordination:
      a. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the finish hardware.
      b. Coordinate the Work of other Sections to provide clearances and accurate positioning of recessed or cast-in-place items.
   5. Related Sections:
      a. Section 06100, Rough Carpentry.
      b. Section 07920, Joint Sealants.
      c. Section 08111, Hollow Metal Doors and Frames.
      d. Section 08131, Stainless Steel Doors and Frames.
      e. Section 08340, Fiber Reinforced Plastic Doors and Frames.

f. Section 08441, Glazed Aluminum Curtain Walls.
g. Section 08800, Glass and Glazing.

1.02 REFERENCES

A. Standards referenced in this Section or referenced in Product Performance Standard are listed below:
1. ANSI A117.1, Accessible and Usable Buildings and Facilities.
2. ANSI/BHMA A156.1, Butts and Hinges.
3. ANSI/BHMA A156.3, Exit Devices.
4. ANSI/BHMA A156.4, Door Controls - Closers.
5. ANSI/BHMA A156.5, Auxiliary Locks and Associated Products.
6. ANSI/BHMA A156.6, Architectural Door Trim.
7. ANSI/BHMA A156.7, Template Hinge Dimensions.
8. ANSI/BHMA A156.8, Door Controls - Overhead Stops and Holders.
9. ANSI/BHMA A156.13, Mortise Locks and Latches, Series 1000.
10. ANSI/BHMA A156.16, American National Standard for Auxiliary Hard-ware.
11. ANSI/BHMA A156.18, Hardware - Materials and Finishes.
12. ANSI/BHMA A156.21, Thresholds.
13. ANSI/BHMA A156.22, Door Gasketing and Edge Seal Systems.
14. ANSI/BHMA A156.24, Delayed Egress Locks.
15. ANSI/DHI A115.1, Preparation of Mortise Locks in 1-3/8-inch and 1-3/4-inch Standard Steel Doors and Frames.
16. ANSI/NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
17. ASTM E329, Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
18. FF-TT-S-00227.
19. ICC/IBC - International Building Code
20. NIST, U. S. Standard.
21. NFPA 70, National Electric Code.
22. NFPA 80, Fire Doors and Fire Windows.
23. NFPA 101, Life Safety Code.
24. NFPA 105 - Installation of Smoke Door Assemblies.
25. SDI 109, Hardware for Standard Steel Doors and Frames.
26. SDI 118, Basic Fire Door Requirements.
27. UL 10B, Fire Tests of Door Assemblies.
28. UL 10C, Positive Pressure Fire Tests of Door Assemblies.
29. UL 305 - Panic Hardware.
30. UL, Building Materials Directory.
31. UL, List of Inspected Fire Protection Equipment and Material.
32. ANSI/UL 437- Key Locks
33. State Building Codes, with Local Amendments

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Provide finish hardware and accessories manufactured by firms specializing in the production of this type of Work and complying with specified standards of ANSI, BHMA, DHI, NFPA, HMMA, SDI and UL.
   2. Provide finish hardware from manufacturers who are members of BHMA and participate in BHMA certification programs.

B. Installer's Qualifications:
   1. The finish hardware installer shall have in his employ an architectural hardware consultant. The architectural hardware consultant shall be a member of the Door and Hardware Institute, (DHI), who has passed the DHI certification examine and successfully completed an apprenticeship program. The architectural hardware consultant shall be responsible for preparing finish hardware schedules and Shop Drawings and be present at the Site for the purpose of checking and supervising the Work of the installer during the time of installation and adjustment of the finish hardware Work, and shall prepare a written field report on status of completed finish hardware installation as specified.
   2. Submit name and qualifications of the installer and hardware consultant to Engineer.

C. Architectural Hardware Consultant Qualifications:
   1. A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

D. Component Supply and Compatibility:
   1. Finish hardware equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   2. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the finish hardware manufacturer.
   3. Testing Agency Qualifications: The independent testing agency shall demonstrate to Engineer's satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated in accordance with ASTM E 329, without delaying the Work.

E. Source Quality Control:
   1. Obtain each type of finish hardware item from only one manufacturer.
   2. Provide finish hardware schedule, for submission to, and for approval by, Engineer, prepared in compliance with specified DHI standards.
   3. Comply with specified BHMA standards.

F. Testing Agency Qualifications: The independent testing agency shall demonstrate to Engineer's satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated in accordance with ASTM E 329, without delaying the Work.

G. Requirements of Regulatory Agencies:
   1. Provide door finish hardware for fire-resistance-rated openings in compliance with NFPA 80.
   2. Provide only finish hardware that has been tested, listed and labeled by UL for the types and sizes of doors required, and complies with the requirements of the door and door frame labels.
   3. Modify features of finish hardware items specified, and provide additional accessories and features as required to meet UL and NFPA 80 requirements, at no additional cost to the Owner.
   4. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches or less above the sill.

H. Preconstruction and Keying Conference: Conduct conference at Project site to comply with requirements in the Contract Documents. In addition to Owner, Contractor, and Architect, conference participants shall also include Architectural Hardware Consultant and Owner's security consultant.
   1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review required testing, inspecting, and certifying procedures.
   3. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
      a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
      b. Preliminary key system schematic diagram.
      c. Requirements for key control system.
      d. Address for delivery of keys.

1.04 SUBMITTALS

A. Action Submittals
   1. Shop Drawings: Submit the following:
      a. Copies of manufacturer's data for each item of finish hardware. Include whatever information may be required to show compliance with specified requirements, and include instructions for installation and for maintenance of operating parts and exposed finishes. Include mounting heights and locations for each item of finish hardware. Provide Architect with latest complete technical catalogue of all available finish hardware manufactured by proposed manufacturers, even if manufacturer specified by Architect is submitted by Contractor to perform the Work. Furnish templates to fabricators of other Work, which is to receive finish hardware.

b. Copies of the Door Finish Hardware Schedule, prepared by the Architectural Hardware Consultant, in the manner and format specified, complying with the actual construction Progress Schedule requirements (for each draft). Include explanation of abbreviations, symbols, and codes used to present scheduled information.
    1) Prepare and submit Door Finish Hardware Schedule in compliance with DHI standards.
    2) Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
    3) Include the following information:
        (a) Type, style, function, size, label, hand, and finish of each door hardware item.
        (b) Manufacturer of each item.
        (c) Fastenings and other pertinent information.
        (d) Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
        (e) Explanation of abbreviations, symbols, and codes contained in schedule.
        (f) Mounting locations for door hardware.
        (g) Door and frame sizes and materials.
        (h) Warranty information for each product.
        (i) Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

c. Based on the finish hardware requirements specified, organize the final Door Finish Hardware Schedule into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other Work which may be critical in the Project Schedule. Furnish final draft of schedule after Samples, manufacturer's data sheets, coordination with Shop Drawings for other Work, delivery schedules and similar information have been completed and accepted.

d. Include a separate keying schedule, showing clearly how Owner’s final instructions on keying of locks have been fulfilled. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

e. Door Finish Hardware Schedules are intended for coordination of the Work. The Architect’s review will be for general quality and features of units;

compliance with all other requirements is the exclusive responsibility of the Contractor. Review and acceptance by Architect does not relieve Contractor of responsibility to fulfill the requirements as shown and specified.

f. Field Report: Architectural Hardware Consultant's Written field report on condition of each item of finish hardware actually present on each door at the project site with each item referenced to approved Shop Drawings. Final approval or final payment shall not be provided to Contractor until field report has been submitted to and approved by the Architect.

g. Maintenance Manual: Upon completion of the Work, furnish five copies of detailed maintenance manuals, including the following information:
   1) Product name and manufacturer.
   2) Name, address, e-mail address and telephone number of manufacturer and local distributor.
   3) Detailed procedure for routine maintenance and cleaning.
   4) Detailed procedures for repairs such as dents, scratches and staining.
   5) Parts identification manual and maintenance manuals for each piece of finish hardware.

h. Samples
   1) A six(6) inch sample of each type of strip and saddle specified.

B. Informational Submittals
   1. Test Reports: Submit for approval certified independent laboratory test reports for BHMA certification program and certification tests for each type of product specified.
   2. Qualification Data:
      a. Installer.
      b. Architectural Hardware Consultant.

C. Closeout Submittals
   1. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Project Closeout.
   2. Project Record Documents: Provide record documentation of as-built door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Division 01.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver all items of finish hardware in manufacturer's original, undamaged packages, bearing accurate representation of the item within each package.
   2. Pack each piece of finish hardware separately, complete with screws, keying, instructions and templates, tagged to correspond with items submitted on approved Shop Drawings and as specified.
   3. Storage and Protection:

a. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
b. Provide secure storage area for finish hardware items, secured by locks and accessible only to finish hardware installer, Architect and Contractor.
c. Store finish hardware in manufacturers' original packages.

4. Acceptance at Site:
   a. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Architect, in writing, if any loss or damage exists to equipment or components. Items that arrive in a damaged condition shall be removed from the Site and not offered again for acceptance. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.
   b. Hardware shall be checked against the approved hardware schedule upon delivering to the project site by hardware supplier and after it is installed to insure proper operation.

1.06 COORDINATION

A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including excessive deflection, cracking, or breakage.
      b. Faulty operation of operators and door hardware.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
      d. Warranty Period: 3 years from date of Substantial Completion, except as follows:
         1) Exit Devices: 2 years from date of Substantial Completion.
         2) Manual Closers: 10 years from date of Substantial Completion.

1.08 MAINTENANCE

A. Maintenance Service
   1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

2. Maintenance Service: Beginning at Substantial Completion, provide 6 months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies same as those used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.01 SYSTEM PERFORMANCE

A. Design Criteria:
   1. Where the finish, shape, size, fire-resistance-rating, frequency of use, or function of a member receiving finish hardware is such as to prevent, or make unsuitable, the types of finish hardware specified, furnish similar types having as nearly as practicable the same operation but of type or kind more appropriate to the design intention and requirements of governing authorities having jurisdiction at the Site. Clearly identify and highlight to Architect all such required modifications on Shop Drawings submitted for approval.
   2. If finish hardware for any location is not specified, provide finish hardware equal in design and quality to adjacent finish hardware specified for comparable openings at no additional cost to Owner.
   3. Furnish finish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements, as necessary for proper installation and function.
   4. Unless otherwise specified, comply with DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames and Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.

2.02 DETAILS OF CONSTRUCTION

A. General:
   1. Hand of Door: The Drawings show the swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish each item of finish hardware for proper installation and operation of the door swing as shown.
   2. Manufacturer's Name Plate: Do not use manufacturer's products which have manufacturer's name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with labels required by governing authorities having jurisdiction at the Site.
   3. Base Metals: Produce finish hardware units of the basic metal and forming method specified, using the manufacturer's standard metal alloy, composition, temper and hardness. Do not substitute materials or forming methods for those specified.
   4. Fasteners: Manufacture door finish hardware to conform to published templates, generally prepared for machine screw installation. Do not provide finish

hardware, which has been prepared for self-tapping sheet metal screws, except as specifically indicated.

5. Furnish screws for installation, with each finish hardware item. Provide Phillips flat-head screws except as otherwise specified. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces on other Work, to match the finish of such other Work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.
6. Provide fasteners which are compatible with both the unit fastened and the substrate, and which will not cause corrosion or deterioration of finish hardware, base material or fastener.
7. Provide concealed fasteners for finish hardware units, which are not exposed when the door is closed, except to the extent no standard manufacturer units of the type specified are available with concealed fasteners. Do not use through bolts for installation where the bolt head or the nut on the opposite face is exposed in other Work under any condition, except where it is not possible to adequately reinforce the Work and use machine screws or concealed fasteners of another standard type to satisfactorily avoid the use of through bolts.
8. Tools for Maintenance: Furnish two complete sets of specialized tools as required for Owner's continued adjustment, maintenance, removal and replacement of finish hardware.

2.03 HARDWARE TYPES

A. Mortise Hinges:
   1. Templates and Screws: Provide only template-produced units.
   2. Base Metal: Except as otherwise specified, fabricate hinges from stainless steel and finish to match the latch and lock set.
   3. Number of Hinges: Provide three hinges on each door leaf of less than 60-inches in height; provide one additional hinge for next 30-inches of door height or fraction thereof; provide two additional hinges for each 30-inches, or fraction thereof, for doors above 90-inches tall.
   4. Hinge Size: Except as otherwise specified or as required to comply with UL and NFPA, provide hinges of the following sizes:
      a. Interior Doors:
         1) Average Use, Maximum 36-Inches Wide: 4-1/2-inch standard weight (0.134-inches).
         2) Heavy Use, Maximum 36-Inches Wide: 4-1/2-inch heavy-weight (0.180-inches).
         3) Wide, 37-inches to 48-inches wide: 5-inch heavy-weight.
      b. Exterior Doors, Maximum 36-Inches Wide: 4-1/2-inch heavy-weight (0.180-inch). For doors 37-inches to 48-inches wide: 5-inch heavy-weight.
   5. Types of Hinges: Provide full-mortise type, ball-bearing hinges, swaged for mortise applications, inner leaf beveled, square cornered, unless manufacturer's recommendations indicate that half-mortise, half-surface, full-surface or other type should be used for the frame and door type or condition.

6. Hinge Pins: Except as otherwise specified, provide hinge pins as follows:
    a. Pins: Stainless steel.
    b. Exterior Doors: Non-removable pins. Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed.
    c. Tips: Slope ends of hinge barrel.
7. Conform to ANSI/BHMA A156.7.
8. Comply with UL, List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
9. Products and Manufacturers: Provide one of the following:
    a. FBB 199 and FBB 191 by Stanley Commercial Hardware, Division of The Stanley Works.
    b. T4B3386 and TB3313 by McKinney Products Company, an ASSA ABLOY Group company.
    c. TA/T4A Series, 5-knuckle by McKinney Products Company, an ASSA ABLOY Group Company.

B. Heavy-Duty Continuous Geared hinges:
1. Provide: Continuous Concealed Geared Full Surface Hinges: Complying with ANSI/BHMA A156.26, 6063-T6 aluminum, manufactured of 3 interlocking aluminum extrusions (2 hinges leaves and 1 cover channel), door leaf and jamb leaf geared together for entire hinge length and joined by cover channel.
2. Templates and Screws: Provide only template-produced units.
3. Hinge Length: 1-inch shorter than nominal height of door.
4. Hinge Grade: Extra Heavy Duty.
5. Product and Manufacturer: Provide one of the following:
    a. 1200-600 XHD by Hager Companies.
    b. Pemko CFM HD1-M.
    c. Manufacturer required / recommendation for doors in Curtain Wall.
    d. Or approved equal.
6. Provide continuous hinges for all FRP doors.

C. High-Security Mortise Locks:
1. Strikes: Provide manufacturer's standard wrought box strike, for each location and use shown. Provide stainless steel curved lip strikes, unless otherwise recommended by manufacturer, finished to match lock or latch set trim.
2. Lock Throw: Provide minimum of 3/4-inch anti-friction stainless steel latch bolt and 1-inch dead bolt throw. Comply with UL requirements for throw of latch bolts and deadbolts on fire-resistance-rated openings.
3. Materials: Provide the following features and materials:
    a. Latch Bolt: Two-piece; mechanical; anti-friction, stainless steel.
    b. Dead Bolt: One-piece, stainless steel with two enclosed hardened-steel roller armor pins.
    c. Case: 12-gauge wrought steel, zinc dichromatized.

d. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5 - E09211A.
e. Armor Front: 8-inches by 1-1/4-inches wide, minimum; steel.
f. Escutcheon: 8-inches by 2-1/2-inches wide by 3/16-inches thick, minimum; stainless steel, US 32D.
g. Hubs: Sintered steel, copper infiltrated.
h. Lever with Stop Pin: Brass, plated to match stainless steel, with additional built-in stop to prevent over-torquing of lever.
i. All components shall be of marine quality, wherever possible.
j. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies.
k. Meets UL Certification Directory ZHLL.R21744 for products used in windstorm rated assemblies.

4. Backset: 2-3/4-inches.
5. Modify specified locks and latches to comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
6. Latches and Locks for Means of Egress Doors: Comply with NFPA 101.
7. Finish: US 32D satin.
8. Conform to ANSI/BHMA A156.13, Series 1000, Security Grade 1.
9. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.
10. Product and Manufacturer: Provide one of the following:
    a. ACCENTRA, formerly known as Yale (YA) - 8800FL Series by ASSA ABLOY.
    b. Manufacturer required / recommendation for doors in Curtain Wall.
    c. Or approved equal

D. Panic Exit Devices:
1. Strikes: Provide manufacturer's standard wrought stainless steel jamb-mounted top latch bolt and bottom latch bolt for each location and use shown to allow independent opening and closing of each leaf of double doors with panic exit devices; complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
2. Lock Throws: Provide minimum of 3/4-inch latch bolt throw complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
3. Provide concealed vertical rod type exit device and mortise type exit devices as specified.
    a. Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
4. Provide the following features and materials:
    a. Latch Bolt: Two-piece; mechanical; anti-friction, stainless steel.

b. Dead Bolt: One-piece, stainless steel with two enclosed hardened-steel roller armor pins.
c. Case: Wrought steel, zinc dichromatized.
d. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5 - E09211A.
e. Armor Front: 8-inches by 1-1/4-inches wide, minimum; steel.
f. Escutcheon: 8-inches by 2-1/2-inches wide by 3/16-inches thick, minimum; stainless steel, US 32D.
g. Hubs: Sintered steel, copper infiltrated.
h. Crossbar: Oval, seamless with interlocking expansion collets and roll pins; knurled, satin stainless steel, 0.062-inches minimum thickness, with steel reinforcing tube.
i. Concealed bolts: Minimum 1/2-inch diameter, stainless steel.
j. Backset: Provide minimum backset of 2-3/4-inches.
k. Finish: US 32D satin.

5. ANSI/BHMA: A156.3, Type 3 and Type 8, Grade 1; F08, entrance by lever, key locks or unlocks lever for entrances shown as accessible to people with disabilities as required by ADAAG; and F05, entrance by thumb piece, key locks or unlocks thumb piece.
6. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
7. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
8. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
9. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
10. Flush End Caps: Provide flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.
11. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
    a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
    c. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.
12. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.
13. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

14. Rail Sizing: Provide exit device rails factory sized for proper door width application.
15. Products and Manufacturers: Provide one of the following:
    a. ACCENTRA, formerly known as Yale (YA) - 6000 Series, by ASSA ABLOY Group company.
    b. 1530-L8 (F) and -T8 (F) Series Mortise Exit Devices and 1520(F) CVR Concealed Vertical Rod Exit Devices; with Escutcheon Trim and Augusta - ASL Lever Handles and Thumbpiece/Handle/Cylinder Unit by Yale Commercial Locks and Hardware, an ASSA ABLOY Group company.
    c. ED6600Series Mortise Exit Devices and ED 6800 Concealed Vertical Rod Exit Devices; with Escutcheon Trim and Newport – N4M Lever Handles and D Grip T7M Thumb piece/Handle/Cylinder Unit by Corbin Russwin Architectural Hardware, an ASSA ABLOY Group company.
    d. Manufacturer required / recommendation for doors in Curtain Wall.

E. Cylinders and Keying System:
1. Review the keying system with Owner has and provide the type required to integrate with Owner's existing system.
2. Furnish all locks with manufacturer's cylinders for interchangeable-core pin tumbler inserts. Furnish only temporary inserts for the construction period, and remove these before Substantial Completion. Construction control keys and cores shall not be part of Owner's permanent keying system. Permanent cores and keys shall be furnished to Owner prior to Substantial Completion.
3. Comply with the Owner's instructions for master keying and, except as otherwise specified, provide individual change key for each lock which is not designated to be keyed alike with a group of related locks.
4. Permanent keys and cores shall be stamped with the applicable key mark for identification. These visual key control marks or codes shall not include the actual key cuts. Permanent keys shall also be stamped "DO NOT DUPLICATE".
5. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
    a. Threaded mortise cylinders with rings and cams to suit hardware application.
    b. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
    c. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
    d. Tubular deadlocks and other auxiliary locks.
    e. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
    f. Keyway: Match Facility Standard.
6. Cylinder Material: Brass, bronze or Series 300 stainless steel.
7. Cylinder Features: Seven-pin, high-security, removable core.
8. Key Material: Nickel silver.
9. Key Quantity: Furnish three keys for each lock and five keys for each master and grandmaster system. Provide one extra key blank for each lock. All keys are to be shipped directly to County Locksmith Department.

10. Key Registration List (Bitting List):
    a. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
    b. Provide transcript list in writing or electronic file as directed by the Owner.
11. Products and Manufacturers: Provide one of the following:
    a. Match Owners standard existing in the field which may include:
        1) Schlage Primus XP
        2) Sargent Restricted System
        3) Manufacturer required / recommendation for doors in Curtain Wall.

F. Overhead, Surface-Mounted, Door Closers:
1. Provide all doors, unless specially shown or specified as being provided with floor-mounted or concealed overhead closers, with surface-mounted overhead door closers. Provide both active and inactive door leafs with closers.
2. Closers General:
    a. Heavy-Duty: Heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
    b. Unitrol: Closers with door stop mechanism to absorb dead stop shock on arm and top hinge. Hold-open arms to have a spring loaded mechanism in addition to shock absorber assembly. Arms to be provided with rigid steel main arm and secondary arm lengths proportional to the door width.
    c. Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
3. Size of Units: Except as otherwise specified, comply with the manufacturer's recommendations for size of door control unit, depending upon size of door, exposure to weather, and anticipated frequency of use.
4. Where parallel arms are specified, and for closers on exterior doors, provide closer unit one size larger than recommended for use with standard arms.
5. Use parallel arm arrangement for doors that would otherwise have the door closer appearing in finished corridors or entries.
6. Comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials, and NFPA 80. Modify closers specified as required. UL 10C and UBC 7-2c positive pressure requirements for fire-rated openings.
7. Provide hold open feature for all non-fire-resistant-rated doors, unless otherwise specified.
8. Provide offset bracket mounting on exterior doors. Select all arms to clear weather-stripping, and overhead door holders.
9. Provide long arm to allow door to swing 180 degrees where long arm will eliminate floor-mounted stops.

10. Provide closers with spring power adjustment feature capable of increasing spring power 15 percent minimum in all closer sizes.
11. Provide individual regulating valves for closing and latching speeds, and separate adjustable back check valve.
12. Provide delayed closing action feature on all door closers. Position valve at top of closure.
13. Provide the following materials and features:
    a. Full Metal Cover: Aluminum.
    b. Case: Cast-iron.
    c. Arms: Plated to match full metal covers.
    d. Other Parts: Steel.
    e. Extreme temperature fluid.
    f. Security torx machine screws.
    g. Ten-year warranty.
    h. Provide manufacturer's optional corrosion protection.
14. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets
15. Finishes: US 26D satin chrome. Color coordinate all arms and other accessories.
16. Highly Corrosive Atmospheres: Provide all closers with specified manufacturer's optional corrosion protection.
17. ANSI/BHMA: A156.4, Grade 1.
18. Products and Manufacturers: Provide one of the following:
    a. DC8000 Series by Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
    b. 4040 Series by LCN Closers, an Ingersoll Rand Company.
    c. 7500 Series by Norton Rixson, an ASSA ABLOY Group company.
    d. Manufacturer required / recommendation for doors in Curtain Wall.

G. Coordinators:
1. Provide coordinator device on all pairs of doors required or specified to have automatic flush bolts, or panic exit devices. Comply with UL, List of Inspected Fire Protection Equipment and Material, and NFPA No. 80 requirements. Meets ANSI/BHMA A156.3, Type 21A.
2. Provide manufacturer’s standard carry bar and strike on all pairs of doors equipped with coordinator.
3. Materials: Aluminum.
4. Finish: US26D Satin Chrome Plated
5. Coordinate Placement of coordinator with overhead closers and flush bolts.
6. Product and Manufacturer: Provide one of the following:
    a. COR with FL filler bar by Ives, Part of Allegion
    b. Or approved equal.

H. Astragals:

1. Provide metal split-astragal bars, not less than 1/8-inch by 2-inches, for exposed flathead screw mounting on both leafs of all pairs of doors. Comply with UL and NFPA requirements for types and locations of astragals.
2. Provide astragal of extruded aluminum with clear anodized finish.
3. Products and Manufacturers: Provide one of the following:
   a. No. 351 Series by Pemko Manufacturing Company.
   b. No. McK297 by McKinney, an ASSA ABLOY Group company.
   c. Or equal.

I. Weatherstrip Gasketing:
1. Provide perimeter weatherstrip at all exterior doors, provide smoke, light, or sound gasketing for interior doors where scheduled in the Finish Hardware Schedule, at end of Part 3.
2. Continuity of Gasketing: Except as otherwise specified, stripping at each opening shall be continuous and without unnecessary interruptions at door corners and hardware.
3. Replaceable Seal Strips: Resilient or flexible seal strip of every unit shall be easily replaceable and readily available from stocks maintained by the manufacturer.
4. Provide bumper-type weatherstrip at jambs and head, including a resilient insert and metal retainer strip, surface-applied, of the following metal, finish and resilient bumper material:
   a. Housing: Extruded aluminum with dark bronze anodized finish; 0.062-inch minimum thickness of main walls and flanges.
   b. Dimensions: 1-3/8-inches by 7/8-inches, stop-mounted.
   c. Seals: Closed-cell extruded silicone.
   d. ANSI/BHMA: A156.22, R3E264.
   e. Products and Manufacturers: Provide one of the following:
      1) No. 350DSPK and 2891 DPK (for parallel arms) by Pemko Manufacturing Company.
      2) S88BL (for head and jambs) by Pemko Manufacturing Company.
      3) No. 770D Compress-O-Matic and No. 429A (for parallel arms) by Zero International.
      4) Or equal.
5. Provide heavy-duty, surface-mounted, automatic drop-seal door-bottom unit of manufacturer's standard design, with operating seal bar of the following material, retained in an extruded metal bar and capable of operating to close a 3/4-inch gap (from door bottom to floor or threshold). House mechanism and operating bar in the following metal housing, for mounting in doors as follows:
   a. Housing: Extruded aluminum, 0.062-inch thick, with mill aluminum finish.
   b. Seal: Neoprene.
   c. Mounting: Surface-mounted.
   d. ANSI/BHMA: A156.22, R3E344.
   e. Products and Manufacturers: Provide one of the following:
      1) No. 4301 DPKL by Pemko Manufacturing Company.

2) No. 367 D by Zero International.
3) Or equal.

6. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
   a. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
7. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
   a. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
8. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

J. Standard Thresholds:
   1. All exterior and interior doors shall be provided with thresholds.
   2. Metal: Mill finish extruded aluminum.
   3. Surface Pattern: Fluted tread, manufacturer's standard.
   4. Provide countersunk stainless steel screws and expansion shields.
   5. Width: 6-1/8-inches wide and of length sufficient to span full width of rough openings, coped and scribed neatly at and around door frames.
   6. Construction:
      a. Two-piece, complying with manufacturer's recommendations.
   7. Profile: Provide manufacturer's unit, which conforms to the minimum size and profile requirements specified.
      a. For doors equipped with panic hardware, including floor bolts, provide profile with stop bar of proper size and shape to function as the strike plate for the floor bolts.
   8. Thickness: 1/2-inch, minimum.
   9. ANSI/BHMA: A156.21, J12100.
   10. Products and Manufacturers: Provide one of the following:
      a. 253A3FG by Pemko Manufacturing Company.
      b. 8426A by National Guard Products.
      c. Manufacturer required / recommendation for doors in Curtain Wall.
      d. Or approved equal.

K. Custom Thresholds:
   1. All exterior doors shall be provided with thermal barrier thresholds.
   2. Metal: Diamond Plate stainless steel 0.25” thick diamond plate with non-slip epoxy abrasive photo luminescent particles bonded to surface.
   3. Surface Pattern: Fluted tread, manufacturer's standard.
   4. Provide countersunk stainless steel screws and expansion shields.

5. Width: 5 1/8-inches wide and of length sufficient to span full width of rough openings, coped and scribed neatly at and around door frames.
6. Construction:
    a. Single-piece, complying with manufacturer's recommendations.
7. Profile: Provide manufacturer's unit, which conforms to the minimum size and profile requirements specified.
8. Thickness: 1/2-inch minimum.
9. ANSI/BHMA: A156.21, J12100.
10. Products and Manufacturers: Provide one of the following:
    a. Custom Order #669 DP-STST-EL Stainless Steel as manufactured by Zero. Refer to contract drawing for profile.
    b. Manufacturer required / recommendation for doors in Curtain Wall.
    c. Or equal by Pemko or National Guard Products.

L. Silencers:
1. Provide silencers for all door frames.
2. Provide pneumatic design that, once installed, forms an air pocket to reduce noise.
3. Provide minimum of three per strike side of door jambs.
4. ANSI/BHMA: A156.16, BHMA 6.5, L03011.
5. Products and Manufacturers: Provide one of the following:
    a. SR64 by IVES Hardware, an Ingersoll-Rand Company.
    b. Series 307D by Hager Companies.
    c. Or equal.

M. Wall and Floor Stops: Provide the following where scheduled in List of Finish Hardware Items at end of Part 3:
1. Dome-Type Floor Stops:
    a. Cast bronze extra heavy-duty wall mounted door stop, one per leaf.
    b. Coordinate height of dome-type floor mounted doors stops with threshold condition and undercut of door.
    c. Finish: US 26D satin chrome.
    d. ANSI/BHMA: A156.16, Grade 1, L12161.
    e. Products and Manufacturers: Provide one of the following:
        1) FS13/ R14, FS17 by IVES Hardware, an Ingersoll-Rand Company.
        2) Trimco BL243F by Triangle Brass Manufacturing Company.
        3) Rockwood.
2. Wall Stops:
    a. Cast bronze extra heavy-duty wall mounted door stop, one per leaf.
    b. Convex rubber bumper.
    c. ANSI/BHMA: A156.16, L12101.
    d. Products and Manufacturers: Provide one of the following:
        1) WS401CVX by IVES Hardware, an Ingersoll-Rand Company.
        2) Trimco 230W by Triangle Brass Manufacturing Company.
        3) Rockwood model RM860.

N. Automatic and Constant Latching Flush Bolts:
   1. Latch: Inactive door remains latched until the active door is opened, releasing the automatic bottom bolt and then the top bolt can be manually released. Inactive door will relatch automatically when closed.
   2. Compliance: BHMA A156.16, fits standard ANSI A115.4 door and Frame preparations.
   3. Non-handed, with ¾ backset.
   4. Products and Manufacturers: Provide one of the following:
      a. FB5IP by Ives, an Allegion division.
      b. Manufacturer required / recommendation for doors in Curtain Wall.
      c. Or equal by Hager or Rockwood.

O. Dust-Proof Strikes:
   1. Provide brass dust-proof strikes which incorporate a slotted plunger raised to flush position by spring tension for all flush bolts.
   2. Provide 5/8-inch inside diameter dust-proof strikes; threshold mounted and surface mounted.
   3. Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
      a. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
      b. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
      c. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
      d. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
   4. Standards: Comply with the following:
      a. Strikes for Mortise Locks and Latches: BHMA A156.13.
      b. Strikes for Bored Locks and Latches: BHMA A156.2.
      c. Strikes for Auxiliary Deadlocks: BHMA A156.36.
      d. Dustproof Strikes: BHMA A156.16.
   5. Finish: B.H.M.A. 610, US 7 Satin brass, blackened, bright relieved, clear coated.
   6. Products and Manufacturer: Provide one of the following:
      a. DP-1 and DP-2 by Ives, an Allegion company.
      b. Or approved equal by Hager or Rockwood.

P. Door Protective Trim
   1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
   2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and

provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:
   a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
   a. Rockwood (RO).
   b. Manufacturer required / recommendation for doors in Curtain Wall.
   c. Or approved equal.

Q. Sealants: Provide elastomeric sealant complying with FS TT-S-00227, Type 2 (non-sag) Class A for use with thresholds.

2.04 HARDWARE FINISHES

A. Provide matching finishes for finish hardware units at each door or opening, to the greatest extent possible in compliance with NIST U. S. Standards or ANSI/BHMA A156.18.

B. Reduce differences in color and textures as much as commercially possible where the base metal or metal forming process is different for individual units of finish hardware exposed at the same door or opening. In general, match all items to the manufacturer's standard finish for the latch and lock set for color and texture.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine the substrate to receive finish hardware, and the conditions under which the Work will be performed, and notify the Architect, in writing, of unsatisfactory conditions. Do not proceed with the finish hardware Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.02 PREPARATION

A. Templates: Furnish finish hardware templates to each fabricator of doors, frames and other Work to be factory-prepared for the installation of finish hardware. Check the Shop Drawings of such other Work, to confirm that adequate provisions are made for the proper installation of the finish hardware.

B. Prepare Work to receive finish hardware Work in compliance with ANSI/DHI A115.1.

C. Surface-Applied Door Hardware: NFPA 80: Drill and tap doors and frames according to ANSI A250.6.

3.03 INSTALLATION

A. Installer shall check and approve the installation before operation. Installer shall assure that the system operates to the Owner's satisfaction.

B. Mount finish hardware units at heights recommended in, Door and Hardware Institute, "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames" and "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames", except as otherwise specified or required to comply with governing authorities having jurisdiction at the Site, HMMA 830 and ADAAG requirements.

C. Install each finish hardware item in compliance with the manufacturer's instructions and recommendations and approved Shop Drawings. Wherever cutting and fitting is required to install finish hardware onto or into surfaces that are later to be painted or finished in another way, install each item completely, then remove, and store in a secure place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the substrate.

D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

E. Drill and countersink units that are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

F. Cut and fit threshold and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.

G. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel that will not corrode in contact with the threshold metal.

H. Set thresholds in a bead of elastomeric sealant to completely fill concealed voids and exclude moisture from every source. Do not plug drainage holes or block weeps. Remove excess sealant before sealant cures to a firm set.

I. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Lubricate moving parts with the type lubrication recommended by manufacturer (graphite-type if no other recommended). Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

J. Final Adjustment: Where finish hardware installation is made more than one month prior to Substantial Completion, return to the Work during the week prior to acceptance or occupancy, and make a final check and adjustment of all finish hardware items in each space and area. Clean and re-lubricate operating items as necessary to restore proper function and finish of finish hardware and doors. Adjust door control devices to compensate for final operating of heating and ventilating equipment.

K. Provide manufacturer's authorized representative to instruct and train Owner's personnel in proper adjustment and maintenance of finish hardware during the final adjustment of finish hardware.

L. Finish hardware, which is blemished or defective, will be rejected even though it was set in place before defects were discovered. Remove and replace with new finish hardware. Repair all resultant damage to other Work.

M. Continued Maintenance Service: Approximately six months after the acceptance of finish hardware in each area, the installer, accompanied by the representative of the latch and lock manufacturer and Architectural Hardware Consultant, shall return to the Project and re-adjust every item of hardware to restore proper function of doors and finish hardware. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures. Clean and lubricate operational items wherever required. Replace finish hardware items that have deteriorated or failed due to faulty design, materials or installation of finish hardware units.

3.04 FIELD QUALITY CONTROL

A. Provide a written field report, prepared by installer's Architectural Hardware Consultant, identifying actual condition, location, manufacturer, and product designation for each item of finish hardware actually present on each door at the Site, including whether finish hardware is adjusted and operating properly, compared with each item referenced to approved Shop Drawings and Contract requirements.

B. Installer's Architectural Hardware Consultant shall provide opinions to, and assist Engineer in determining, acceptability of installation as Work proceeds. All comments and discussions, conversations and meetings with Engineer shall be included in written field report for submission to Engineer for review and approval at completion of finish hardware installation.

C. As part of written field report to be submitted to Engineer for approval, recommend remedial actions for Work not in compliance with these Specifications. No payment for Work shall be made until remedial recommendations and actions have been approved by Engineer and incorporated into the Work.

3.05 DOOR FINISH HARDWARE SCHEDULE

A. Scheduled items for each door are generic and rely on information specified above. Contractor shall submit a Door Finish Hardware Schedule acceptable to all governing authorities having jurisdiction at the Site.

B. Provide the following finish hardware items:
   1. HDW Set 1.0 (Exterior, No UL label) Door 107B, 108B, coordinate with Curtain Wall manufacturer's requirements.
      a. Continuous geared hinge.
      b. Exit Device, Classroom.
      c. Cylinder.
      d. Overhead Surface-Mounted Door Closer with parallel arm, Unitrol.
      e. Custom Threshold.
   2. HDW Set 2.0 (Exterior, UL label) Door 103B, 201B, 301
      a. Continuous hinge.
      b. Fire Rated Exit Device, Classroom.
      c. Cylinder.
      d. Overhead Surface-Mounted Door Closer, Unitrol.
      e. Custom Thermally Broken Threshold.
      f. Weatherstripping.
      g. Rain Guard.
      h. Sweep.
   3. HDW Set 2.1 (Exterior, No UL label) Door 001, coordinate with Curtain Wall manufacturer's requirements.
      a. Continuous hinge.
      b. Exit Device, Classroom.
      c. Cylinder.
      d. Overhead Surface-Mounted Door Closer, Unitrol
      e. Custom Thermally Broken Threshold.
      f. Weatherstripping.
      g. Rain Guard.
      h. Sweep.
      i. Door Bottom.
   4. HDW Set 3.0 (Exterior, No UL label) Door 110, coordinate with Curtain Wall manufacturer's requirements.
      a. Continuous hinge.
      b. Mortise Lockset, Passage.
      c. Overhead Surface-Mounted Door Closer.
      d. Custom Threshold.
      e. Wall Stop.
   5. HDW Set 4.0 (Interior, Pair, UL label) Door 103A
      a. Mortise hinges (3 pair).
      b. Fire Rated Surface Vertical Exit Device, Passage.
      c. Fire Rated Surface Vertical Exit Device, Exit Only.

d. Overhead Surface-Mounted Door Closer (2).
e. Kickplate (2).
f. Wall Stop.
g. Astragal (2).
h. Acoustic Perimeter seals.
i. Threshold.

6. HDW Set 5.0 (Interior, Pair, UL label) Door 202
   a. Mortise hinges (3 pair).
   b. Fire Rated Surface Vertical Exit Device, Passage.
   c. Fire Rated Surface Vertical Exit Device, Exit Only.
   d. Overhead Surface-Mounted Door Closer (2).
   e. Kickplate (2).
   f. Astragal.
   g. Gasketing.
7. HDW Set 6.0 (Interior, UL label) Door 101, 104, 105, 201A
   a. Mortise hinges (1 1/2 pair).
   b. Fire Rated Surface Vertical Exit Device, Passage.
   c. Overhead Surface-Mounted Door Closer.
   d. Kickplate.
   e. Gasketing.
   f. Wall Stop.
8. HDW Set 7.0 (Interior, UL label) Door 102A, 106
   a. Mortise hinges (1 1/2 pair).
   b. Fire Rated Surface Vertical Exit Device, Passage.
   c. Overhead Surface-Mounted Door Closer, Unitrol.
   d. Kickplate.
   e. Gasketing.
9. HDW Set 7.1 (Interior, UL label, STC Rated) Door 102B
   a. Mortise hinges (1 1/2 pair).
   b. Fire Rated Surface Vertical Exit Device, Passage.
   c. Overhead Surface-Mounted Door Closer, Unitrol.
   d. Kickplate.
   e. Acoustic Perimeter seals.
   f. Threshold.
10. HDW Set 8.0 (Exterior, Pair, No UL label) Door 201C
    a. Mortise hinges (3 pair).
    b. Fire Rated Surface Vertical Exit Device, Storeroom.
    c. Fire Rated Surface Vertical Exit Device, Exit Only.
    d. Cylinder.
    e. Overhead Surface-Mounted Door Closer (2), Unitrol.
    f. Kickplate (2).
    g. Astragal.
    h. Weatherstripping.
    i. Sweep.

j. Thermally Broken Threshold.

11. HDW Set 9.0 (Exterior, UL label) Door 107A, 108A
    a. Mortise hinges (1 1/2 pair).
    b. Fire Rated Surface Vertical Exit Device, Passage.
    c. Overhead Surface-Mounted Door Closer.
    d. Kickplate.
    e. Wall Stop.
    f. Weatherstripping.
    g. Rain Guard.
    h. Sweep.
    i. Thermally Broken Threshold.
12. HDW Set 10.0 (Exterior, UL label) Door 204
    a. Continuous Hinge.
    b. Fire Rated Surface Vertical Exit Device, Passage.
    c. Overhead Surface-Mounted Door Closer, Unitrol.
    d. Kickplate.
    e. Weatherstripping.
    f. Rain Guard.
    g. Door Bottom.
    h. Sweep.
    i. Thermally Broken Threshold.
13. HDW Set 12.0 (Interior, No UL label) Door 111
    a. Mortise hinges (1 1/2 pair).
    b. Mortise Lockset, Passage.
    c. Overhead Surface-Mounted Door Closer.
    d. Kickplate.
    e. Wall Stop.
14. HDW Set 15.0 (Exterior overhead door) Door 103C
    a. Hardware per door manufacturer.
15. Note, hardware sets 11, 13, and 14 not used.

+ + END OF SECTION + +

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SECTION 08800

GLASS AND GLAZING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install glass and glazing.
   2. Extent of glass and glazing is shown.
   3. Types of products required include the following.
      a. Insulated Laminated Glass
      b. Insulated Spandrel Glass
      c. Laminated Safety Glass
      d. Fire Rated Glass.
      e. Structural and non-structural glazing sealants.
      f. Miscellaneous glazing, spacers, tapes and other materials.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the glass and glazing Work.

C. Related Sections:
   1. Section 07461, Preformed Metal Siding.
   2. Section 07920, Joint Sealants.
   3. Section 08131, Stainless Steel Doors and Frames.
   4. Section 08225, FPR Doors with Aluminum Frames.
   5. Section 08441, Glazed Aluminum Curtain Walls.

1.02 REFERENCES

A. Standards referenced in this Section or referenced in Product Performance Standards are listed below:
   1. AAMA 800, Voluntary Specifications and Test Methods for Sealants.
   2. ANSI Z97.1, Safety Glazing Materials Used in Buildings.
   3. ASTM C162 – Standard Terminology of Glass and Glass Products.
   4. ANSI/ASTM E 1300, Practice for Determining Load Resistance of Glass in Buildings.
   5. ASCE 7, Minimum Design Loads for Buildings and Other Structures.
   6. ASTM C 864, Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
   7. ASTM C 920, Specification for Elastomeric Joint Sealants.

8. ASTM C 1021, Practice for Laboratories Engaged in Testing of Building Sealants.
9. ASTM C 1036, Specification for Flat Glass.
10. ASTM C 1048, Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
11. ASTM C 1172, Specification for Laminated Architectural Flat Glass.
12. ASTM C 1376, Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Glass.
13. ASTM E 1300, Standard Practice for Determining the Minimum Thickness and Type of Glass Required to Resist a Specified Load.
14. ASTM E 2188, Standard Test Method for Insulating Glass Unit Performance.
15. ASTM E 2189, Standard Test Method for Testing Resistance to Fogging in Insulating Glass Units.
16. ASTM E 2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.
17. 16 CFR, Consumer Product Safety Commission, CPSC Part 1201, Safety Standard for Architectural Glazing Materials.
18. GANA, Glazing Manual.
19. GANA, Laminated Glass Design Guide.
20. GANA, Glass Tempering Division, GTA 95-1-31, Specification for Decorative Architectural Flat Glass.
21. GANA Sealant Manual; Glass Association of North America.
22. GANA/GTA 66-9-20, Specification for Heat-Strengthened or Fully Tempered Ceramic Enameled Spandrel Glass for Use in Building Window/ Curtain Walls and Other Architectural Applications.

1.03 QUALITY ASSURANCE

A. Primary Glass Manufacturer and Glazing Materials Manufacturer Qualifications:
   1. Provide glass and glazing materials manufactured by firms specializing in the production of the types of glass and glazing products specified, in compliance with specified standards.
   2. Provide glass from manufacturers who are members of GANA and PGMC and participate in certification programs.
   3. Obtain glass and glazing materials from manufacturers who will send a qualified technical representative to the Site, for the purpose of advising the installer of proper procedures and precautions for the use of the materials and who will assist Engineer with opinions on the acceptability of materials and Work.

B. Fabricator Qualifications:
   1. Provide laminated and insulating glass fabrications from fabricators who are licensed by primary glass manufacturer to produce specified units and with documented skill and successful experience in this type of Work and who agree to employ only tradesmen who are trained, skilled and have successful experience in this type of Work.

2. Provide laminated and insulating glass fabrications from fabricators who are members of GANA or SIGMA and participate in certification programs.
3. Obtain laminated and insulating glass fabrications from fabricators who will, if required, send a qualified technical representative to the Site, for the purpose of assisting the Architect with opinions on the acceptability of materials and installation methods.

C. Installer's Qualifications:
1. The installer of the glass and glazing materials shall be a firm with documented skill and successful experience in the installation of the types of materials required and who agrees to employee only tradesmen who are trained, skilled and have successful experience in the types of materials and glazing systems specified and who are certified under the National Glass Association Glazier Certification Program as Level 3 (Master Glaziers).
2. Submit records of experience and certifications to the Architect.

D. Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this section or referenced standards:
1. GANA Publications
2. AAMA Publications
3. IGMA/IGMAC Publications

E. Safety glass products in the US are to comply with CPSC 16 CFR Part 1201 for Category II materials.

F. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing specified, as documented according to ASTM E 548.

G. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct testing specified, as documented according to ASTM E 548.

H. Source Limitation: All materials provided under this Section shall be obtained from a single supplier or manufacturer who, with Contractor, shall assume full responsibility for the completeness of the Work. The supplier or manufacturer shall be the source of information on all material furnished regardless of the manufacturing source of that material.

I. Regulatory Requirements:
1. Safety Glass: Comply with ANSI Z97.1, with label on each piece of glass as required by governing authorities having jurisdiction.
2. Insulating Glass products are to be permanently marked either on spacers or at least one insulating unit component with appropriate certification label of Insulating Glass Certification Council (IGCC).

J. Codes: Comply with applicable requirements of codes referenced in Contract Documents.

1.04 SUBMITTALS

A. Samples: Submit the following:
   1. 12-inch square samples of each type of glass required.
   2. Insulating glass samples need not be hermetically sealed, but edge construction, wavelength-selective interlayer and low-E coatings shall be included and identified. Include specially prepared samples with each interlayer film product's identity marked on film and incorporated into sample.
   3. Submit 12-inch long samples of each color for each type of exposed-to-view glazing sealant and gasket. Install sample between two strips of material similar to, or representative of, channel surfaces where sealant or gasket will be used, held apart to represent typical joint widths.
   4. Review of samples by Architect will be for color, texture and pattern only. Compliance with other requirements is the responsibility of Contractor.

B. Shop Drawings: Submit the following:
   1. Copies of manufacturers' specifications, product data sheets, installation instructions for each type of glass, glazing sealant or compound, gasket and associated miscellaneous material and all recommended installation precautions for required materials and components, which are not included in other submittals, specified in other Sections. Coordinate the submittal of such other data with this submittal, and with the submittal of samples required by other Sections.
   2. Structural performance calculations indicating that detailing and fabrication have been based on the results of the required analysis and performance criteria specified.
   3. Plans and elevations showing location of each type and kind of glass specified and details of glazing system. Include manufacturer's recommendations for glazing.
   4. Manufacturer’s and fabricator’s guarantees, as specified.
   5. Fabricator's qualifications.
   6. Installer's qualifications.
   7. Performance analysis of each configuration of insulating glass incorporating wavelength selective interlayer or low E coating using LBL-35-298, Window 4.1.
   8. Certification that fabricated products comply with manufacturer's published performance.
   9. Dimensions and details of manufacturer's glue line thickness and bite dimensions and verifications.

C. Test Reports: Submit the following:
   1. Certified laboratory test reports for required performance tests in compliance with ASTM E548.
   2. Provide wavelength-selective insulating glass or low-E glass manufacturer's computer-aided sheet engineering analysis to determine deflection and rabbet depth for individual applications, specified loadings, performance requirements,

support criteria and other parameters, in order to indicate compliance with these Specifications.

3. Wavelength-selective polyester film insulating glass or low-E glass fabricator's computer performance analysis of each glass configuration including two (2) filled interlayers for insulating glass units.
4. Structural silicone sealant performance features and calculations indicating sealant joints have been detailed and fabricated in compliance with silicone sealant manufacturer's recommended guidelines for dissimilar metal adhesion. Structural and other performance calculations for the structural silicone joints shall be prepared, signed and stamped with the seal of a Registered Professional Engineer, licensed to practice in the State of New York, and recognized as an expert in the required Work.
5. Adhesion and compatibility test report from glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.
6. Certified laboratory test reports for required performance tests in compliance with NFRC CAP 1 Certification Agency Program.

D. Certificates of Compliance: Submit the following:
   1. Certification that all glass materials subject to the applicable standards of the CPSC are in compliance. The certification shall be issued in conformance with procedures stated in the standard.
   2. Include primary glass manufacturers and fabricators published data, and letters of certification, based on certified test laboratory reports, indicating that each material complies with specified requirements and is acceptable for the applications shown.
   3. Certification that fabricated products comply with manufacturer's published performance.

E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
   2. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
   3. Transport large panes of glass in vertical position with spacers to prevent contact between panes and edges.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

2. Protect glass and glazing materials according to manufacturer's and fabricator's written instructions to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
3. For insulating glass that will be exposed to substantial altitude changes, comply with insulating glass fabricator's written recommendations for venting and sealing to avoid hermetic seal ruptures.
4. Glass delivered to the job site with manufacturer's markings are applied at the job, use either neutral or slightly acidic adhesive. In no case shall marking materials or adhesives be alkaline. Any staining of glass by alkaline material will be cause for rejection.
5. The edges of all tempered and insulating glass shall be protected from damage and edges shall not be modified in any way after the glass leaves the factory. Nipping of any glass to reduce size will not be permitted.
6. All glass shall be delivered with manufacturer's labels showing type, thickness and quality of the material (and UL label is required). These labels shall not be removed until the glass is set and final approval has been secured.

C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Architect, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

D. Field Measurements: When construction schedule permits, verify field measurements with drawing dimensions prior to fabrication of glass products.

1.06 SPECIAL WARRANTIES

A. General: The special warranties specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents.

B. Special Warranties:
1. Laminated Glass: Provide written warranty, signed by the fabricator and Contractor and running to benefit of Owner, agreeing to replace, for a period of five-years from the date of Substantial Completion, glass units that show deterioration, as specified. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
2. Insulating Glass and Spandrel: Provide written warranty, signed by the fabricator and Contractor and running to the benefit of Owner, agreeing to replace, for a period of ten-years from the date of Substantial Completion, glass that shows signs of deterioration, as specified. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to

manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

3. Coated Glass: Provide written warranty, signed by the fabricator and Contractor and running to the benefit of Owner, agreeing to replace, for a period of ten-years from the date of Substantial Completion, glass that shows signs of deterioration, as specified. Defects include peeling, cracking, and other indications of deterioration in coating.
4. Structural Silicone: Provide structural silicone manufacturer's twenty-year limited adhesion warranty and non-staining warranty for silicone structural adhesive, commencing from the date of Substantial Completion. Perform all testing required to achieve the warranties.

C. Workmanship Guarantee:
   1. The contractor shall guarantee all work against defective material or workmanship for a period of one year following acceptance of the work.

PART 2 - PRODUCTS

2.01 SYSTEM PERFORMANCE

A. Design Criteria: For glass performance, manufacture, size, type, construction and thickness, comply with the following:
   1. Provide glass and glazing systems capable of withstanding normal thermal movements and wind and impact loads without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants (both structural and weather-resisting) to remain watertight, airtight and to maintain structural performance characteristics specified; deterioration of glazing materials; or other defects in construction.
   2. Windborne-Debris-Impact Resistance: Provide exterior glazing that passes enhanced-protection testing requirements in ASTM E1996 for Wind Zone 3 when tested according to ASTM E1886. Test specimens shall be no smaller in width and length than glazing indicated for use on the Project and shall be installed in same manner as glazing indicated for use on the Project.
      a. Large-Missile Test: For all glazing, regardless of height above grade.
   3. Normal Thermal Movement: Provide glass that allows for thermal movements resulting from a maximum temperature range of 120°F in ambient and 180°F surface temperature acting on glass framing members and glazing components. Base structural performance calculations on surface temperatures of materials caused by both solar heat gain and nighttime-sky loss.
   4. Comply with requirements of Consumer Product Safety Commission, Part 1201, Safety Standards for Architectural Glazing Materials, for all the Work.
   5. Structural Performance: Provide structural calculations for analysis of required glass thicknesses for glass lites shown, that are used to establish final fabricating and detailing requirements. Indicate compliance with the following minimum criteria for all glass shown:

a. Project Wind Speed: 132 miles per hour based on ASCE 7-16 and the building code of New York State.
b. Importance Factor: Category 1.25.
c. Exposure Category: Exposure C; Ce = 1.0.
d. Wind Stagnation Pressure: qs = 44.6 psf.
e. Long-Duration Loading: One month.
f. Short-Duration Loading: Sixty seconds, based on three-second gust speed.
g. Probability of Breakage for Vertical Glazing: Eight lites per 1,000 under wind action.
h. Maximum Lateral Deflection: For glass supported on all four edges, provide thickness required to limit center deflection at design wind pressure to 1/50 times the short side length or 1-inch, whichever is less.

6. Glass thicknesses shown are minimums. Confirm glass thicknesses by analyzing Project structural loadings and in-service conditions using glass manufacturer's recommended load tables and other structural performance criteria specified. Where manufacturer's load tables indicate acceptability of lesser thickness material than required by performance criteria specified, provide specified thicknesses and features as a minimum. Where load tables indicate the need for greater thickness, or additional features, than specified, provide greater thicknesses and features at no additional cost to Owner. Comply with practice for determining minimum thickness and types of glass, to resist loadings required by governing authorities having jurisdiction at the Site, according to ANSI/ASTM E 1300.
7. Test sealant in accordance with sealant manufacturer's recommendations.
8. Provide each configuration of insulating glass incorporating wavelength-selective interlayers or low-E coatings.
9. Glazing Sealant System Compatibility:
   a. Glazing sealants shall be compatible with the channel surfaces, joint fillers, insulating glass sealing system, laminated glass interlayer material and other materials in contact with the glazing channel in compliance with ASTM C 1087.
   b. Provide only materials and manufacturer's recommended variation of the specified materials, which are known to be fully compatible with the actual installation conditions, as shown by manufacturer's published data or certification submitted to Engineer for approval.
10. Adhesion of Elastomeric Joint Sealants: Comply with ASTM C 793 and ASTM C 794.
11. Center-of-Glass U-Values: NFRC 100 methodology using LBL-35298 WINDOW 4.1 computer-aided software design, expressed as Btu/square foot by height by degree F.
12. Center-of-Glass Solar Heat Gain Coefficient: NFRC 200 methodology using LBL-35298 WINDOW 4.1 computer-aided software design.
13. Solar Optical Properties: NFRC 300.

B. Definitions:

1. Sealed Insulating Glass Unit Surfaces and Coating Orientation:
    a. Surface 1- Exterior surface of outer pane (surfacing facing outdoors of outboard lite).
    b. Surface 2- Interior surface of outer pane (surface facing indoors of outboard lite).
    c. Surface 3- Exterior surface of inner pane (surface facing outdoors of inboard lite.)
    d. Surface 4- Room side surface of inner pane (surfacing facing indoors of inboard lite.)
2. Ceramic Enamel Frit Spandrel Glass: Glass that has been rendered opaque with a fired on ceramic enamel frit paint for non-vision applications.
3. Two-ply laminated glass: Two sheets of monolithic glass bonded together with a plastic interlayer by heat and pressure.

2.02 MANUFACTURERS

A. Manufacturers shall be as listed below:
    1. Oldcastle Glass.
    2. PPG Industries.
    3. Viracon, Inc.
    4. Pilkington, Inc.

2.03 MATERIALS

A. Insulated, Fully Tempered Glass (All exterior door vision lites)
    1. Insulating Glass Units: Provide preassembled units consisting of two lites of glass separated by a dehydrated interspace, and complying with ASTM E 2190 for Class C units, permanently and hermetically sealed together at edges with spacers and sealant.
    2. System Sealing: Dual seal with polyisobutylene primary sealant and silicone secondary sealant, complying with ASTM C 1249.

B. Laminated Glass: ASTM C1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
    1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written recommendations.
    2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
    3. Interlayer Color: Clear unless otherwise indicated.

C. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, with "Windborne-Debris-Impact Resistance" Paragraph in "Glass Products, General" Article, and with other requirements specified. Use materials that have a proven

record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with the following to comply with interlayer manufacturer's written recommendations:
   a. Polyvinyl butyral interlayer.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

D. Insulating glass, Type 1, for window units included in Section 07461 – Preformed Metal Siding, 6'-0" x 6'-0" maximum size (unit types 'A', 'B', 'C', 'J', and 'K') shall be nominally 1.09375 inch thick hermetically sealed units located as shown on drawings, consisting of:
   1. Outboard Lite 1/4-inch Pilkington Arctic Blue Eclipse Advantage Radiant Low-E#2.
   2. Air Space 13/32-inch Spacer (argon-filled)
   3. Inboard Lite: 7/16-inch Clear Tempered
      a. Surface #3: 3/16-inch Clear
      b. Interlayer: 0.075-inch StormGlass
      c. Surface #4: 3/16-inch Clear
   4. Transmittance:
      a. Visible Light: 35%
      b. Solar Energy: 18%
      c. Ultraviolet:<1% Ultraviolet defined as 300 to 380 nanometers (nm)
   5. Reflectance:
      a. Visible Light Exterior: 13%
      b. Visible Light Interior: 29%
      c. Solar Energy: 8%
   6. Performance Values:
      a. Winter Nighttime U-Value: 0.31 Btu/hr-ft2-°F
      b. Shading Coefficient: 0.32
      c. Solar Heat Gain Coefficient: 0.28
      d. Light to Solar Gain: 1.24

E. Insulating glass, Type 2, for curtain wall units included in Section 08441 – Glazed Aluminum Curtain Walls, up to 5'-0" x 10'-0" (unit types 'X') shall be nominally 1.6375 inch thick hermetically sealed units located as shown on drawings, consisting of:
   1. Outboard Lite 1/2-inch Custom Blue Laminate
      a. Outer Ply: 1/4-inch Pilkington Arctic Blue
      b. Interlayer: 0.075-inch StormGlass
      c. Inner Ply: 3/16-inch Clear
   2. Air Space 7/16-inch Spacer (argon-filled)
   3. Inboard Lite: 3/16-inch SunGuard Super Neutral 68 on Clear.
      a. Surface #5: Low-E.

4. Transmittance:
    a. Visible Light: 9%
    b. Solar Energy: 4%
    c. Ultraviolet:<1% Ultraviolet defined as 300 to 380 nanometers (nm)
5. Reflectance:
    a. Visible Light Exterior: 9%
    b. Visible Light Interior: 20%
    c. Solar Energy: 7%
6. Performance Values:
    a. Winter Nighttime U-Value: 0.24 Btu/hr-ft2-°F
    b. Summer Daytime: 0.24 Btu/hr-ft2-°F
    c. Shading Coefficient: 0.12
    d. Solar Heat Gain Coefficient: 0.12
    e. Light to Solar Gain: 0.77

F. Insulating spandrel glass, Type 3, for curtain wall units included in Section 08441 – Glazed Aluminum Curtain Walls, up to 5'-0" x 10'-0" (unit types 'D') shall be nominally 1.6375 inch thick hermetically sealed units located as shown on drawings, consisting of the same composition as Type 2 with a ceramic enamel frit applied to the interior facing surface to provide an opaque finish where indicated on drawings.

G. Fire Resistance Rated Glass: Multi-laminate Fire-Rated (45 to 120 minutes), Impact Safety-Rated Fireglass multi-laminate glass with clear intumescent interlayers, interior and exterior use, meets CPSC 16 CFR 1201 (Cat. I and II) and ANSI Z97.1 and providing protection against radiant and conductive heat transfer as per ASTM E119 and UL 263, withstands thermal shock. 5-year limited warranty. .
    1. Products : Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
        a. Pilkington Pyrostop: 90-102: 90 min., 1 7/16 inch thick, STC 45, U-Value -.74.
        b. AGC Pyrobel by McGrory Glass: 45-120: 45 min., 3/4 inch thick.
        c. Architect approved equivalent.

2.04 GLAZING SEALANTS, TAPES AND GASKETS

A. General:
    1. Colors: Provide black or other natural color wherever no other color is available. Wherever material is not exposed-to-view, provide manufacturer's standard color, which has the best overall performance characteristics for the application shown.
        a. Provide manufacturer's standard colors as shown or, if not shown, provide color selected by Engineer from manufacturer's standard colors to either blend or contrast with adjoining surfaces.
    2. Hardness specified is intended to indicate the general range necessary for overall performance. Submit glazing and sealant manufacturer's recommendations for actual hardness for each condition of installation and use. Except as shown or

specified, provide glazing materials within the following ranges of hardness (Shore A, fully cured, at 75°F):

a. 15 to 35 for elastomeric compounds and tapes used with rigid stops and frames for large glass sizes (in excess of 100 united inches). Provide material sufficiently hard to withstand exposure to abrasion and vandalism.
b. 25 to 50 for rubber-like curing compounds used with rigid stops and frames for medium and small glass sizes (less than 100 united inches). Provide materials sufficiently hard to withstand impact of moving sash and doors.
c. 35 to 60 for molded gaskets used with rigid stops and frames, depending upon strength needed for application or insertion of units.
d. 75 to 80 for structural gaskets (not supported by stops).

3. Provide size and shape of gaskets and preformed glazing units as recommended by the manufacturer and as indicated on approved Shop Drawings.
4. Comply with ASTM C 920 and other requirements for each liquid-applied, chemically curing sealant specified.
5. Where additional movement capability is specified, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement, in compliance with ASTM C719, to withstand the specified percentage change in the joint width existing at the time of installation and remain in compliance with other requirements in ASTM C920 for uses shown.

B. Preformed Butyl Rubber Back-Bedding Mastic Glazing Tape:
1. Preformed tape of polymerized butyl or mixture of butyl and polyisobutylene with inert fillers with built-in spacer of synthetic rubber, solvent-based with minimum 95 percent solids, non-sag consistency, tack-free time of 24 hours or less, paintable, non-staining, complying with AAMA 806.3.
2. Products and Manufacturers: Provide one of the following:
a. Polyshim II Glazing Tape by Tremco, Incorporated.
b. Extru-Seal Butyl Glazing Tape by Pecora Corporation.
c. Or equal.

C. Dense Compression Wedge Gaskets:
1. Provide molded or extruded, closed-cell silicone wedge gaskets in compliance with ASTM C1115, Type C.

D. Exterior, One-Part, Silicone Rubber Sealant:
1. Silicone rubber-based, one-part elastomeric sealant, complying with ASTM C920, Type S, Grade NS, Class 25, Use NT, M, G, A and O.
2. Products and Manufacturers: Provide one of the following:
a. Spectrem I by Tremco, Incorporated.
b. 863 Architectural Silicone Sealant by Pecora Corporation.
c. Or equal.

E. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.05 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standards, requirements of manufacturers of glass and glazing materials for applications shown, and approved Shop Drawings. Provide materials with a proven record of compatibility with surfaces shown and specified.

B. Setting Blocks: Elastomeric material, 80 to 90 Shore A durometer hardness, with proven compatibility with sealants used in the Work and as recommended by the glass manufacturer.

C. Spacers and Edge Blocks: Elastomeric blocks or continuous extrusions, with a Shore A durometer hardness recommended by glass manufacturer to maintain lites in place and to limit lateral movement for installation shown, and with proven compatibility with sealants used in the Work.

D. Cylindrical Glazing Sealant Backing: Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam complying with ASTM C1330, Type O (open-cell material), proven to be compatible with sealants used, flexible and resilient, with 5 to 10 psi compression strength for 25 percent deflection.

E. Cleaners, Primers and Sealers: Type recommended by sealant, gasket and glass manufacturer.

2.06 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Glass manufacturer's recommended glazing channel dimensions are intended to provide for necessary minimum bite on the glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances. Contractor shall be responsible for correct glass size for each opening, within the tolerances and necessary dimensions established on approved Shop Drawings.

2.07 TOLERANCES

A. Allowable Tolerances: Provide fully tempered and heat-strengthened glass, formed by horizontal roller-hearth process, free of tong marks, and not exceeding the following flatness tolerances (either face, any direction, any location) based on 1/4-inch glass thickness with inversely proportionate tolerances for other thicknesses:
   1. For 12-inch Run: 1/16-inch bow.
   2. For 3-foot Run: 1/8-inch bow.
   3. For 7-foot Run: 1/4-inch bow.
   4. For 10-foot Run: 3/8-inch bow.

2.08 SOURCE QUALITY CONTROL

A. To the greatest extent possible, provide each type of glass and glazing materials from one manufacturer.

B. Providing insulating glass with a certified Class A rating according to SIGMA.

C. Obtain glass and sealant test results for product test reports from qualified testing agencies regularly engaged in the business of testing glass and sealant products.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glass and glazing is to be performed, and notify Architect, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the glazing until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

B. Environmental Requirements: Installation of glass products at ambient air temperature below 40 degrees F is prohibited.

3.02 PREPARATION

A. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings, which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are used.

B. Apply primer or sealer to joint surfaces wherever recommended by sealant and glass manufacturer.

3.03 INSTALLATION

A. General:
   1. Comply with combined recommendations of glass, window and glazing products manufacturers and other materials used in glazing, except where more stringent requirements are shown or specified, and as shown on approved Shop Drawings.
   2. Comply with GANA, Glazing Manual, except as shown and specified otherwise, and except as specifically recommended otherwise by the manufacturers of the glass and glazing materials, as accepted by Engineer on approved Shop Drawings.
   3. Inspect each piece of glass immediately before installation, and remove from Site all that have observable edge damage or face imperfections.
   4. Unify appearance of each series of lights by setting each piece to match others as nearly as possible. Inspect each piece and set with pattern, draw and bow oriented in the same direction as other pieces.
   5. Cut and install tinted glass as recommended in manufacturer's technical bulletin as provided on approved Shop Drawings.
   6. Install sealants as recommended by sealant manufacturers, and as recommended on approved Shop Drawings.
   7. Do not attempt to cut, seam, nip or abrade glass on Site, which is tempered, heat strengthened, or coated.

8. Do not proceed with installation of liquid glazing sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
9. Proceed with glazing only when forecasted weather conditions are favorable to proper cure and development of high early bond strength. Wherever channel action is affected by ambient temperature variations, install glazing sealants only when temperatures are in the middle third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation or compression, and bond stress will not be excessive at extremely low or high temperatures.
10. Coordinate the installation of the glass and glazing Work with the Progress Schedule in order to avoid delay of Project.

B. Tape and Sealant Glazing:
1. Place setting blocks in sill rabbets, sized and located to comply with referenced glazing publications. Set blocks in thin course of compatible sealant for heel bead. Position glass on setting blocks and press against tape for full contact.
2. Provide spacers for glass lites where the length plus width is larger than 4 foot-2 inches. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
3. Provide 1/8-inch minimum bite for spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
4. Provide edge spacers shown on approved Shop Drawings and as required to prevent glass lites from moving sideways in glazing channel.
5. Cut glazing tape to length and set against permanent stops. Install horizontal strips first, extending over width of opening, before applying vertical strips.
6. Remove paper backing from tape. Place glazing tape on free perimeter of glass. Install tapes continuously. Do not stretch tape to make them fit openings. Place joints in tapes at corners of openings with adjoining lengths butted together, not lapped. Seal butt joints of tape with joint sealant.
7. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
8. Install removable stop, avoiding displacement of tape, and exert pressure on tape for full continuous contact. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops. Calk space above glazing tape to top of glazing stop. Tool exposed surfaces of sealant compounds to provide a substantial "wash" away from the glass.

9. Clean and trim excess glazing materials from the installation, and eliminate stains and discolorations.
10. Where wedge-shaped gaskets are driven into one side of the channel to pressurize the sealant or gasket on the opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when subjected to dynamic movement. Anchor gasket to stop with matching ribs, or by proven adhesives, including embedment of gasket tail in cured heel bead. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
11. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended on approved Shop Drawings and to prevent corners from pulling away; seal corner joints and butt joints with sealant as recommended by gasket manufacturer and as shown on approved Shop Drawings.

C. Dry Gasket Glazing: Install glass in gaskets as recommended by the glass and window manufacturer. Refer to Section 08131, Stainless Steel Doors and Frames.

D. Structural Sealant Glazing: Install glass using a system of structural silicone sealants as recommended by the glass and sealant manufacturers.

E. Cure glazing sealants and compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

F. The installer shall advise Contractor of procedures required for the protection of glass and glazing sealants and compounds during the construction period, so that they will be without deterioration or damage, other than normal weathering, at the time of Substantial Completion.

G. Furnish specific instructions on the precautions and provisions required to prevent glass damage resulting from the alkaline wash from concrete surfaces and similar sources of possible damage.

H. Protect exterior glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surfaces of glass.

I. Remove and replace glass, which is broken, chipped, cracked, abraded or damaged in other ways during the construction period, including natural causes, accidents and vandalism.

J. Maintain glass in a reasonably clean condition during construction, so that it will not be damaged by corrosive action and will not contribute (by wash-off) to the deterioration of glazing materials and other work.

K. Remove non-permanent labels and wash and polish glass on both faces not more than four days prior to Substantial Completion. Comply with glass manufacturer's recommendations for cleaning.

3.04 FIELD QUALITY CONTROL

A. Watertight and airtight installation of each piece of glass is required, except as otherwise shown. Each installation must withstand normal temperature changes, wind loading, impact loading (for operating sash and doors) without failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight and air-tight, deterioration of glazing materials and other defects in the Work.

B. After nominal cure of exterior glazing sealants, which are exposed to the weather, test for water leaks. Flood the joint exposure with water directed from a ¾-inch hose held perpendicular to wall face, 2 foot-0 inches from joint, connected to a water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 foot-0 inches per minute.

C. Test approximately five percent of total glazing system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face. Conduct tests in the presence of Architect, who will determine the actual percentage of joints to be tested and the actual period of exposure to water from the hose, based upon the extent of observed leakage, or lack thereof.

D. Repair glazing installation at leaks or, if leakage is excessive, replace glazing sealants as directed by Architect.

E. Wherever nature of observed leakage indicates the possibility of inadequate glazing joint bond strength, Architect may direct that additional testing be performed at a time when joints have been fully cured, followed by natural exposure through both extreme temperatures, and returned to the range of temperature in which it is feasible to conduct testing. Repair or replace Work as required and directed by the Engineer.

3.05 ADJUSTING AND CLEANING

A. Before and after installation, all work shall be properly protected against damage.

B. On completion and prior to turning the project over to the Owner, all metal work and glass shall be cleaned and left in perfect condition. Glass shall be washed outside and inside.

C. Make required adjustments.

D. Thoroughly clean all glass and mirrors just before final acceptance by the Owner, or sooner if authorized by Engineer.

E. Remove excess glazing compound and foreign materials.

F. Replace broken or defective glass and hardened, uneven, defective or otherwise non-complying glazing compound.

+ + END OF SECTION + +

SECTION 08954

FLOOD VENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Agreement, including General and Division of the Project Manual, apply to work of this Section.

1.02 SUMMARY

A. This Section includes Manufactured, Engineered, Certified Flood Vents:

1.03 RELATED SECTIONS

A. Section 04220 - Concrete Unit Masonry.

B. Section 05500 - Metal Fabrications.

1.04 REFERENCES

A. ASCE/SEI 24-14, Flood Resistant Design and Construction.

B. FEMA, 44-CFR, Part 59-60 and 60.3 National Flood Insurance Program (NFIP).

C. FEMA TB 1-2008, Openings in Foundation Walls and Walls of Enclosures for Buildings Located in Special Flood Hazard Areas.

D. FEMA TB 2-2008, Flood Damage-Resistant Materials Requirements.

E. NER-624, National Evaluation Report No. NER-624, July 2007.

F. International Code Council ICC-ES Acceptance Criteria for Automatic Foundation Flood Vents (AC-364), October 2007.

G. International Code Council ICC-ES Acceptance Criteria for Mechanically Operated Flood Vents (AC-364), October 2013.

H. UL - Test for Fire Dampers in conjunction with flood vents.

I. 2020 IECC - International Energy Conservation Code.

1.05 DESIGN / PERFORMANCE REQUIREMENTS

A. Flood Vents must be Engineered Openings complying with the following:
   1. Certifications:

a. International Code Council - Evaluation Service Report (ESR-2074) including Florida Building Code Supplement, California Building and Residential Code Supplement.
b. Florida Building Product Approval (FL5822) approved for use in High Velocity Hurricane Zones (HVHZ) and impact rated garage doors.

2. Compliance:
a. ICC-ES Acceptance Criteria for Mechanically Operated Flood Vents (AC364).
b. FEMA Technical Bulletin 1: Openings in Foundation Walls and Walls of Enclosures (TB-1).
c. NFIP Flood Insurance Manual.
d. American Society of Civil Engineers: Flood Resistant Design and Construction (ASCE-24).
e. International Residential Codes (IRC).
f. International Building Codes (IBC).
g. International Energy Conservation Code (IECC).
h. Florida Building Code (FBC).
i. California Building and Residential Code (CBC and CRC).
j. Houston, TX Code of Ordinances Chapter 19 Floodplain.

1.06 SUBMITTALS

A. Submit under provisions of Section 01300 - Submittals.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum 5 years documented experience.

B. Installer Qualifications: Installer with experience on projects of a similar size and scope with similar installation conditions.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver and store materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Store products in clean, dry area indoors until ready for installation. Store materials in accordance with manufacturer's instructions.

C. Protect materials and finish from damage during handling and installation.

1.09 SEQUENCING

A. Ensure that locating templates and other information required for installation of products of this section are finished affected trades in time to prevent interruption of construction progress.

B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.10 WARRANTY

A. Provide the manufacturer's limited 15-year warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer:
   1. Smart Vent Products, Inc., 430 Andbro Dr., Unit 1, Pitman, NJ 08071. Tel: 877-441-8368. Email: request info (info@smartvent.com); Web: www.smartvent.com. Basis of Design.
   2. Architect approved equivalent.

2.02 FLOOD VENTS

A. General: Vents are constructed of Marine Grade 316 Stainless Steel formed and smooth-welded with a rigid construction. Frames are designed for installation in masonry, concrete, or framed walls, stud walls, garage doors and metal panels. Vents have a pivoting door assembly that is fitted with two patented sealed floats that provide vermin protecting and immediately and automatically release the door upon contact with rising water to relieve unbalanced lateral forces on foundation walls. All flood vents are required to work bi-directionally, without human intervention.

B. Insulated Series: Provide flood protection only. Insulated Core with perimeter weather stripping.
   1. FLOOD VENT Products One Piece Insulated Stacker Model (316 SS Powder Coat):
      a. Amount of vents wide: One solid insulated.
      b. Amount of vents high: Two solid insulated.
      c. Flood Coverage: 400 sq. ft.
      d. Color: Stainless Steel.

C. Accessories:
   1. Installation Clips, four for each single vent.

2. Sealant: HurriBond™ (www.hurribond.com) or equivalent adhesive for masonry surfaces.
3. Adjustable wrench for thru-bolted models and screwdriver for stud wall models.
4. Trim and Sleeves: Sleeves for use in 'un-filled' masonry and for, Fire Walls where 'air space' is required on Exterior Walls and to finish off the inside of openings:
   a. Adjustable Sleeve/Trim #1540-531-15: 12 inches to 15 inches.

D. Powder-Coat Finish: As selected by Architect from Manufacturer's standard colors.

E. Insulated Sealing Kit: Flood Vent Sealing Kit Model #1540-526 to provide tight seal behind the vent opening.
   1. Installed on the interior wall.
   2. Finish: White.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Verify vent locations are ready to receive work, and dimensions are as indicated on shop drawings or as instructed by manufacturers.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Review and coordinate setting drawings, templates and related items that are to be embedded in concrete and masonry.

C. Verify that no obstructions exist that will interfere with the proper operation of the vents.

D. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install vents in at least two different walls space evenly around foundation perimeter and located a maximum of 12 inches higher than the, interior or exterior grade, to the bottom of vent.

C. Install vents plumb, level, square, true t line and rigid.

D. Attach vents securely in place using fasteners supplied or approved by manufacturer.

E. Separate incompatible materials to prevent galvanic corrosion.

F. Adjust flood vents for proper operation.

3.04 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

+ + END OF SECTION + +

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SECTION 09511

SUSPENDED ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended acoustical ceilings as specified herein shall include: metal panel ceiling systems, and all accessories and appurtenances.

B. Acoustical ceilings shall be provided where shown on the Contract Drawings, specified herein, or as required for a complete installation.

1.02 REFERENCES

A. New York State Building Code

B. U.L. - Fire Resistance Directory and Building Material Directory.

C. SS-A118B - Federal Specification

D. ASTM C635 - Specification for Metal Suspension Systems for Acoustical Tile and Lay-In Panels

E. ASTM C636 - Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels

F. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials

G. ASTM E1264 - Classification for Acoustical Ceiling Products

H. ASCE 7 - Minimum Design Loads for Buildings and Other Structures: Architectural, Mechanical and Electrical Components and Systems.

1.03 SYSTEM DESCRIPTION

A. Provide 24-inch square metal ceiling panels with suspension system. Provide perimeter of floating ceiling not secured to walls. Provide edge trim and cove pockets as indicated on drawings. All metal ceilings to have torsion spring hanging clips.

B. Suspended acoustical ceilings shall be complete systems and each shall include, but not be limited to metal ceiling panels, structural suspension system, exposed grid suspension system, trim, accessories and appurtenances as required for a complete installation.

1.04 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: All suspended ceiling work shall comply with fire-resistance ratings as shown, and as required by governing authorities and the New York State Building Code and shall be in accordance with the following requirements:

B. Performance Criteria: Contractor shall provide suspended acoustical ceiling system that conforms to seismic restraints in accordance with the seismic provisions ASCE 7, in conjunction with the current New York State Building Code to the extent that the most stringent provisions are utilized in developing the design seismic forces. Refer to the General Structural Notes on the Structural Drawings for site and structure specific seismic design criteria.

1.05 SUBMITTALS

A. Submit pursuant to Section 01300 - Submittals.

B. The Contractor shall prepare and submit for approval catalog cuts, drawings, and reference materials in accordance with the General Conditions.

C. Submittals shall include the following:
   1. Data: The Contractor shall submit copies of specifications, installation instructions and general recommendations from the acoustical ceiling product manufacturers, for each type of acoustical ceiling product. Manufacturer's data substantiating that the materials comply with the requirements shall be included.
   2. Samples: Color and finish samples of each acoustical ceiling product, including each accessory and miscellaneous material to be used in the Work.
   3. Test Reports: Test data shall be submitted for all fire rated ceiling systems.

D. Maintenance Data: Provide manufacturer's recommended written cleaning and maintenance instructions.

1.06 EXTRA MATERIALS

A. Spare Parts: Two cartons of each type of acoustical panel supplied under these Specifications shall be provided.

B. DELIVERY, STORAGE AND HANDLING
   1. Delivery of Materials:
      a. Materials shall not be delivered to the project site before the time of installation.
      b. Materials shall be delivered in sufficient quantities to allow continuity of the Work.
   2. Storage of Materials:
      a. Materials shall be stored in original, undamaged containers with manufacturer's labels and seals intact.

b. All materials shall be stored in a dry, enclosed area, off the ground and away from all possible contact with water, ice or snow.
c. Damage to materials during storage shall be prevented primarily by minimizing the amount of time they are stored at the job-site before being incorporated into construction systems.

3. Handling of Materials:
   a. Materials shall be handled in such a manner to avoid damage or breakage.
   b. Materials shall not be exposed to detrimental conditions or physical damage. Materials which are so exposed shall be removed from the site and shall not be incorporated into the Work.
   c. Materials shall be handled in such a manner so as to prevent inclusion of foreign matter.
   d. Packages or containers shall not be opened until all necessary preparatory work is complete and installation is to begin immediately. Materials shall not be allowed to become wet or soiled or covered with ice or snow.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent product may be submitted for approval.

B. Metal Panel Ceiling System
   1. Ceilings Plus, Los Angeles, CA: Illusions
   2. Armstrong World Industries, Metalworks Torsion Spring.
   3. Or approved equal.

C. Ceiling Suspension System.
   1. Ceilings Plus, Los Angeles, CA: TSCP-26 DXTS Main T 12ft.
   2. Armstrong World Industries, Prelude XL slotted for Torsion Spring with Axiom Knife Edge Trim.
   3. Or approved equal.

2.02 MATERIALS

A. Metal ceiling panels shall be as follows:
   1. Metal Panel Ceiling Units: Metal ceiling panels shall be formed in adequate thickness in modular size as shown on the Contract Drawings. Finish shall be as selected by the Engineer. Panels shall have minimum 1-1/4-inch deep returns with no distortion at corners. Panels shall be factory-perforated with holes to a minimum of 20 percent open. Perforation pattern shall be as selected by the Engineer. In lieu of 1-inch black fiberglass, a layer of acoustic non-woven material shall be applied on top of the metal panel ceiling system, unless otherwise specified.

a. There shall be no fasteners of any kind visible on exposed face surfaces of ceiling panels or support tees. Downlight openings and sprinkler holes shall be neatly and cleanly factory-perforated as required.
b. The plenum shall be 100 percent accessible with every panel removable. Individual panel access is required; progressive panel access is not acceptable. Series of heavy-duty torsion springs and hanging clip assemblies shall be mounted on every panel to provide downward access.
c. Panels shall have integral deep return edges. Trims or separate panels will not be acceptable. There shall be no exposed fasteners at deep return edges..

B. Suspension systems for acoustical panel ceiling systems, shall be as follows:
1. General: Structural and exposed suspension systems shall include all supporting members and required trim. Exposed suspension systems shall have exposed surfaces of matching color and finish. Suspension systems shall comply with the requirements of ASTM C635 heavy duty classification and shall be as recommended by the manufacturer.
2. Structural Suspension System: Structural system for suspended ceilings shall be rigidly mounted to the structure above and shall consist of 1-1/2- inch cold rolled galvanized steel 0.475 lb. channels clipped to 1/4-inch diameter galvanized steel rod hangers. Channels and rods shall be galvanized in accordance with General Specification 05081.
3. Exposed Suspension System for Fire Rated Acoustical Panels: Suspension system for fire rated lay-in ceilings shall be as approved for UL Design No. G258. Suspension system shall have exposed flanges capped with steel finish shall be as selected by Engineer.
4. Suspension System for Metal Panel Ceiling Units: Supporting system shall consist of factory-formed tee in adequate thickness to support loads in conformance with ASTM C-635 heavy duty classification of grid system. Tees shall be finished to match ceiling panels. Tees shall be factory slotted to accept torsion spring attachment for exterior applications.

C. Anchors and Clips: Structural ceiling grid shall be hung from the structure using galvanized beam clips at steel beams, expansion shields at concrete slabs and slot tabs at metal floor or roof decks.

D. Hangers and Support for Suspended Ceilings: Exposed ceiling suspension system shall be connected directly to the structural suspension system with galvanized direct hang clips. System shall include carrying channels, main runners, cross tees, clamps, angle moldings, clips, spacers, and trim.

E. Tie wire, where required, shall be of 18 gauge stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. The Contractor shall verify that areas to receive acoustical ceiling systems are properly prepared and completed to final elevations.

3.02 INSTALLATION

A. Acoustical ceilings shall be installed in accordance with the manufacturer's recommendations.

B. Ceiling Tile Structural System:
   1. Structural system shall be installed with hanger rods and carrier channels at not more than 4'-6" on center in each direction, and in compliance with ASTM C636.
   2. Exposed grid shall be installed in the pattern shown. Extra hangers shall be provided at lighting fixtures and air diffusers that are supported by the system. Hangers shall be spaced as required to prevent deflection in excess of 1/360 of the span of the cross-T or runner. Accessible tile board hold-down clips shall be installed.
   3. All members shall be aligned for a true, level surface and straight lines.
   4. Borders shall be finished with factory finished wall molding which shall be kept under tension by the use of wall springs. Parallel tile borders shall be 6 inches or larger and equal.
   5. Fire-rated ceiling assemblies shall have a 2 hour U.L., Inc. fire protection rating. Fixture and duct protection boxes shall be installed as required for the specified fire protection rating.

C. Metal Panel Acoustical Ceiling Treatment:
   1. Metal panel ceiling and suspension system shall be installed in strict compliance with the manufacturer's recommendations and as approved. All members shall be aligned for true, level surface and straight lines. The installation shall provide for expansion and contraction of the ceiling system. Suspension system shall be direct hung from the structural suspension system as indicated.
   2. Extra hangers shall be provided at lighting fixtures and air diffusers that are supported by the system. Hangers shall be spaced as required to prevent deflection in excess of 1/360 of the span of the cross-T or runner.
   3. Lengths of panels shall be a minimum of 3-feet and a maximum of 16- feet. Join panels by butting on top of a matching colored interior splice. Joints shall be staggered on adjoining carriers. Acoustical pads shall be placed on panels between panel carriers.
   4. Access panels shall be provided at all areas where access to space above the ceiling is necessary. Location of access panels shall be carefully coordinated with the locations of mechanical equipment requiring access.
   5. Tolerances:

a. Maximum deviation of metal ceiling panels from edge to edge in width shall not exceed 1/8-inch in 10 feet when measured with a straightedge placed at any directional location on the finished surfaces.
b. Maximum deviation of metal ceiling panels shall not exceed 1/4- inch from level in any area or room.

3.03 PROTECTION

A. All components of the Work shall be protected from detrimental weather and damage until construction operations are completed.

B. Work which cannot be covered with complete construction system before onset of weather detrimental to the Work shall be completely covered and protected in such a manner as to deflect water and weather from the installation without damaging adjacent Work.

C. Acoustical ceiling work shall be protected from all damage and abuse until Final Acceptance by the County.

3.04 ADJUSTMENT

A. System components which are dislodged, damaged, expanded, broken, penetrated or crushed after installation shall be replaced immediately with undamaged material in compliance with the Specifications, and properly protected as specified.

3.05 CLEANING

A. General: Soiled or discolored surfaces shall be cleaned following installation. Acoustical units which are damaged or improperly installed shall be removed and replaced.

+ + END OF SECTION + +

SECTION 09900

PAINTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and apply paint systems.
      a. Contractor is responsible for surface preparation and painting of all new and existing interior and exterior items and surfaces throughout the Project areas included under this and other Sections.
   2. Extent of painting includes the Work specified below. Refer to other Articles of this Section where all surfaces of generic types are specified for preparation and painting according to their status, intended function, and location, using the painting system for that surface, function, and location as specified, unless specifically identified on the Drawings as a surface not to receive specified painting system.
      a. All new items except where the natural finish of the material is specified as a corrosion-resistant material not requiring paint; or is specifically indicated in the Contract Documents as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint them the same as adjacent similar materials or areas.
      b. Mechanical and process items to be painted include:
         1) Piping, pipe insulation, pipe hangers, and supports, including electrical conduit.
         2) Ductwork and insulation.
         3) Motors, mechanical equipment, and structural supports.
         4) Building Framing, Structures, and Exposed Metal Deck.
         5) Marking of Piping and Electrical Conduits.
         6) Accessory items.
      c. Surface preparation and painting of all new items, both interior and exterior, and other surfaces, including items furnished by Owner, are included in the Work, except as otherwise shown or specified.
      d. All materials, equipment, piping, galvanized conduit thread repair and all other items interior and exterior, concealed and exposed, submerged, intermittently submerged shall be painted, whether or not specific reference is herein made to the Documents.
      e. Approved stepped-down mock-ups for all painting systems showing all components of the surface preparation and paint system application before start of Work. Check all dry film thicknesses; demonstrate methods of

surface preparation, and methods of application, and obtain Architect's approval of colors and textures to be used in the Work.

B. Coordination:
   1. Review installation, removal, and demolition procedures under other Sections and coordinate them with the Work specified in this Section.
   2. Coordinate painting of areas that will become inaccessible once equipment and similar fixed items have been installed.
   3. Coordinate primers with finish paint materials to provide primers that are compatible with finish paint materials. Review other Sections where primed surfaces are provided, to ensure compatibility of total painting system for each surface. Contractor is responsible for coordinating compatibility of all shop primed and field painted items in other Sections.
   4. Furnish information to Architect on characteristics of finish materials proposed for use and ensure compatibility with prime coats used. Provide barrier coats over incompatible primers or remove and repaint as required. Notify Architect in writing of anticipated problems using specified painting systems with surfaces primed by others. Reprime equipment primed in factory and other factory-primed items that are damaged or scratched.
   5. For surfaces provided with intumescent fire proofing coatings scheduled to be painted, coordinate preparation of surfaces as required of the intumescent coating and paint manufacturers and ensure paint is compatible with and approved for use by the intumescent coating manufacturer.

C. Related Sections:
   1. Section 04220, Unit Masonry
   2. Section 05120, Structural Steel
   3. Section 05300, Metal Decking
   4. Section 05500, Metal Fabrication
   5. Section 07920, Joint Sealants.
   6. Section 08111, Hollow Metal Doors and Frames.

D. Work Not Included: The following Work is not included as painting Work, or are included under other Sections:
   1. Shop Priming: Shop priming of structural metal, miscellaneous metal fabrications, other metal items and fabricated components such as shop-fabricated or factory-painted process equipment, plumbing equipment, heating and ventilating equipment, electrical equipment, and accessories shall conform to applicable requirements of this Section but are included under other Sections.
   2. Pre-finished Items:
      a. Items furnished with such finishes as baked-on enamel, porcelain, and polyvinylidene fluoride shall only be touched up at Site by Contractor using manufacturer's recommended compatible field-applied touchup paint.
      b. Items furnished with finishes such as chrome plating or anodizing.

3. Concealed Surfaces: Non-metallic wall or ceiling surfaces in areas not exposed to view, and generally inaccessible areas.
4. Concrete floors, unless specifically shown as a surface to be painted.
5. Fiberglass grating, treads and doors.
6. Collector bearings, shafts and chains, wood flights, wood stop logs, and wood or fiberglass baffles.
7. Corrosion-Resistant Metal Surfaces: Where the natural oxide of item forms a barrier to corrosion, whether factory- or Site-formed, including such materials as copper, bronze, muntz metal, terne metal, and stainless steel.
8. Operating Parts and Labels:
    a. Do not paint moving parts of operating units, mechanical and electrical parts such as valve and damper operators, linkages, sensing devices, interior of motors, and fan shafts.
    b. Do not paint over labels required by governing authorities having jurisdiction at Site, or equipment identification, performance rating, nameplates, and nomenclature plates.
    c. Cover moving parts and labels during the painting with protective masking. Remove all protective masking upon completion of Work. Remove all paint, coatings, and splatter that comes in contact with such labels.
9. Structural and miscellaneous metals covered with concrete need not receive primers, intermediate, or finish coats of paint, except in the case of dissimilar materials or otherwise noted.
10. Existing structures, equipment, and other existing surfaces and items unless otherwise shown or specified.

E. Description of Colors and Finishes:
1. Color Selection:
    a. A maximum of ten different colors will be selected by Architect in addition to color-coding of pipelines, valves, equipment, ducts, and electrical conduit.
2. Color Coding of Pipelines, Valves, Equipment, and Ducts:
    a. In general, color-coding of pipelines, valves, equipment and ducts shall comply with applicable standards of ANSI A13.1, ANSI Z535.1 and 40 CFR 1910.144. Specifically, provide color-coding for pipelines per Table 09900-B, Pipeline Color Table following below. Colors shall be brilliant, distinctive shades matching the existing colors. Paint colors are provided as a standard of quality; equivalent colors matching these colors will be acceptable to Architect. Provide Architect with direct color comparisons of colors available from Manufacturer submitted at time of Shop Drawing submission.
    b. The color of the final coats shall match as closely as possible, without custom blending, the color of the specific pipeline service.
    c. For equipment on roofs or exposed to view, the color shall be selected by Architect.
3. After approval by Architect of colors and Shop Drawing submittals and prior to beginning painting Work, Architect will furnish color schedules and samples for surfaces to be painted listed in Painting Systems below.

F. Standard Colors: shown as color and designation as provided per Tnemec Company, Inc. Paint color numbers and are provided as a standard of quality; equivalent colors matching these colors are acceptable. Provide with Shop Drawing submittal direct color comparisons of color numbers available from manufacturer submitted
   1. Aqua: Aqua Sky: 10GN
   2. Black: Black; 35GR
   3. Blue: True/Safety Blue; 11SF
   4. Brown: Terra Cotta; 07RD
   5. Charcoa: l Deep Space; GR34
   6. Dark Blue: Old Glory Blue; 78BL
   7. Dark Brown: Medium Bronze; 85BR
   8. Dark Gray: Blackthorn; GR31
   9. Gray: Gray-ANSI 61; 33GR
   10. Green: Spearmint/Safety Green; 09SF
   11. Light Blue: Fontainebleau; 25BL
   12. Light Brown: Twine; 68BR
   13. Light Gray: Light Gray; 32GR
   14. Light Green: Misty Jade; GB38
   15. Olive: Clover; 110GN
   16. Orange: Tangerine/Safety Orange; 04SF
   17. Red: Candy Apple/Safety Red; 06SF
   18. White: White; 11WH
   19. Yellow: Lemon/Safety Yellow; 02SF

1.02 REFERENCES

A. Codes and standards referred to in this Section shall be as follows:
   1. SSPC- Society of Protective Coatings
      a. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
      b. SSPC SP 1, Solvent Cleaning.
      c. SSPC-PA2, Hand Tool Cleaning.
      d. SSPC SP 6, Commercial Blast Cleaning.
      e. SSPC-SP7, Brush-off Blast Cleaning.
      f. SSPC-SP 10, Near-White Blast Cleaning.
      g. SSPC-SP 13, Surface Preparation of Concrete
   2. Fed. Spec.- Federal Specifications and Standards of the Genera; Services Administration
      a. TT-C-542F
      b. TT-650D
      c. TT-P-1511B
      d. TT-P-96D
   3. Mil. Specs.- Specifications and Standards of the Department of Defense of the United States Government
      a. MIL-C-22750F

b. MIL-P-23377G
c. MIL-C-22750F
d. MIL-P-26915C

4. ASTM- American Society for Testing Materials
   a. ASTM C811- Practice for Surface Preparation of Concrete for Application of Chemical-Resistant Resin Monolithic Surfaces
   b. ASTM D3359- Measuring Adhesion by Tape Test
   c. ASTM D4258- Practice for Surface Cleaning Concrete for Coating
   d. ASTM D4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
   e. ASTM D4541, Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion-Testers.
   f. ASTM E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
   g. Green Seal, Inc. Paint, (GS-11).
   h. GLUMRB, Recommended Standards for Wastewater Facilities.
   i. National Association of Piping Fabricators, NAPF 500-03, Surface Preparation Standard For Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings And/or Special Internal Linings.

1.03 DEFINITIONS

A. Standard coating terms defined in ASTM D16 apply to this Section, including:
   1. Paint: Pretreatment and all painting system materials, such as primer, emulsion, enamel, organic/inorganic polymer coating, stain sealer and filler, and other applied materials whether used as prime, filler, intermediate, or finish coats.
   2. Exposed: All items not covered with cement plaster, concrete, or fireproofing. Items covered with these materials shall be provided with specified primer only, except where specified as a surface not to be painted. Exposed-to-view surfaces include areas visible after permanent or built-in fixtures, convector covers, ceiling tile, covers for finned tube radiation, grilles, and similar covering products are in areas scheduled to be painted.
   3. Low VOC: All interior and exterior field-applied coatings that have maximum VOC content as listed in OTC Model Rule for Architectural and Industrial Maintenance Coatings.
   4. OTC: Ozone Transport Commission, which recommends standard VOC content levels in several Northeastern and Mid-Atlantic states.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications:
   1. Engage a single applicator that regularly performs installation of paint materials, with documented skill and successful experience in installing types of products required and that agrees to employ only trained, skilled tradesmen who have successful experience in installing types of products specified.

2. Submit name and qualifications to Architect along with following information for at least three successful, completed projects:
    a. Names and telephone numbers of owner and design professional responsible for project.
    b. Approximate contract cost of paint products.
    c. Amount of area painted.
    d. Submit to Architect proof of acceptability of applicator by manufacturer.

B. Testing Agency Qualifications: Provide an independent testing agency for testing specified in this Section. Testing agency shall be selected by Owner and paid for by Contractor. To qualify for approval, submit documentation demonstrating to satisfaction of Architect, that testing agency has experience and capability to satisfactorily conduct testing required without delaying the Work, in accordance with ASTM E329.

C. Source Quality Control:
    1. Obtain materials from manufacturers that will provide services of a qualified manufacturer's representative at Site at commencement of painting Work, to advise on products, mock-ups, installation, and finishing techniques and, at completion of Work, to advise Architect on acceptability of completed Work and during the course of the Work as may be requested by Architect.
    2. Certify long-term compatibility of all coatings with surfaces. Compatible shop and field coats shall be provided.
    3. Do not submit products that decrease number of coats, surface preparation, or generic type and formulation of coatings specified. Products exceeding VOC limits and chemical content specified will not be approved.
    4. Architect may review manufacturers' recommendations concerning methods of installation and number of coats of paint for each painting system. Contractor shall prepare construction costs based on painting systems, number of coats, coverage's and installation methods specified.
    5. Submit "or equal" products, when proposed, with direct comparison to products specified, including information on durability, adhesion, color and gloss retention, percent solids, VOC's grams per liter, and recoatability after curing.
    6. "Or equal" manufacturers shall furnish same color selection as manufacturers specified, including intense chroma and custom pigmented colors in all painting systems.
    7. Color Pigments: Provide pure, non-fading, applicable types to suit surfaces and services to be painted. Comply with:
        a. Lead and Chromate: Lead and chromate content shall not exceed amount permitted by authorities having jurisdiction.
        b. Areas subject to hydrogen sulfide fume exposure will be identified by Architect. Through Contractor, paint manufacturer shall notify Architect of colors that are not suitable for long-term color retention in such areas.

c. Manufacturer shall identify colors that meet the requirements of authorities having jurisdiction at Site for use in locations subject to contact with potable water or water being prepared for use as potable water.
d. Comply with paint manufacturer's recommendations on preventing coating contact with levels of carbon dioxide and carbon monoxide that may cause yellowing during application and initial stages of curing of paint.
e. Obtain each product from one manufacturer. All coats of paint for any particular surface shall be from the same manufacturer. Multiple manufacturing sources for the same system component are unacceptable.
f. Certify product shelf life history for each product source for materials manufactured by the same manufacturer, but purchased and stored at different locations or obtained from different sources.
g. Constantly store materials to be used for painting Work between 60 degrees F and 90 degrees F, and per paint manufacturer's written recommendations, for not more than six months. Certify to Architect that painting materials have been manufactured within six months of installation and have not, nor will be, subjected to freezing temperatures.

D. Regulatory Requirements:
1. Comply with VOC content limits of OTC Model Rule for Architectural and Industrial Maintenance Coatings:
a. Industrial Maintenance Coatings: 340 grams per liter.
b. Interior and Exterior Non-Flat Coatings: 250 grams per liter.
2. Comply with the following:
a. 29 CFR 1910.144, Safety Color Code for Marking Physical Hazards.
b. 40 CFR, Subpart D-2001, National Volatile Organic Compound Emission Standards for Architectural Coatings.
c. Resource Conservation and Recovery Act of 1976 (RCRA).
d. SW-846, Toxic Characteristic Leaching Procedure (TCLP).
3. Comply with authorities having jurisdiction at Site for blast cleaning, confined space entry, and disposition of spent abrasive and debris.
4. Comply with governing regulations for air quality and material disposal regulations. Revise painting systems specified herein in order to provide Supplier's regulatory agency approved coating systems where required.

E. Air Pollution Code Requirements:
1. All paints, solvents, varnish and coatings specified in this contract shall conform to all Ozone Transportation Commission (OTC) requirements
2. The contractor shall furnish the Architect with certification of compliance from the manufacturer that the paints, solvents, varnishes and coatings conform to the Ozone Transportation Commission (OTC) requirements.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Submit the following:
    a. Copies of manufacturer's technical information and test performance data, including paint analysis, VOC and chemical component content in comparison to maximum allowed by the Contact Documents, and application instructions for each product proposed for use.
    b. Submit proof of acceptability of proposed application techniques by paint manufacturers selected.
    c. Copies of Contractor's proposed protection procedures in each area of the Work explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption, and for maintaining acceptable application, curing, and environmental conditions during and after painting systems application.
    d. List each material and cross-reference to the specific painting system and application, including a list of site-specific surfaces to which painting system will be applied. Identify by manufacturer's catalog number and general classification. State number of gallons of each product being purchased for delivery to Site and square foot area calculated to be covered by each painting system specified based on theoretical loss of 20 percent. Where actual area to be covered by paint system exceeds area submitted to Architect for that system, proof of additional material purchase shall be provided to Architect. Calculated coverage shall be as specified for each component of each painting system specified. This requirement does not take precedence over Contractor's responsibility to provide dry film thickness required for each component of each painting system.
    e. Identify maximum exposure times allowable for each paint system component before next coat of paint can be applied. Submit proposed methods for preparing surfaces for subsequent coats if maximum exposure times are exceeded.
    f. Information on curing times and environmental conditions that affect curing time of each paint system component and proposed methods for accommodating variations in curing time. Identify this information for each painting system in the Work.
    g. Specification for spray equipment with cross-reference to paint manufacturer's recommended equipment requirements.
2. Samples: Submit the following:
    a. Color Chart: The Contractor shall submit the manufacturer's standard color chart for color selection for painting of items other than process piping, valves, pipe line equipment, pump casings, blowers and other mechanical equipment and their drive units, all of which shall be in conformance with the "BACKGROUND COLOR" of the General Color Code specified in Division 15.
    b. Paint Samples: The Contractor shall submit two one-quart samples of each required kind of paint material, or the ingredients thereof which are to be mixed in the job. Samples shall be labeled and shall include the certificate of

the manufacturer stating the actual percentages by weight and volume of all ingredients entering into the mixture. Upon request, further samples shall be provided as the work progresses. Painting materials shall not be applied without written approval of samples by the Architect.

c. Painted Surface Samples: Upon request, duplicate samples of the results obtained by painting and finishing various materials on the work shall be submitted. Such samples, and the approved paint applied thereto, shall be applied in strict conformance with these specifications. Finished areas shall be considered adequate for the purpose of determining the quality if the work. All painting work shall be performed in a quality equal to the approved samples. Where equipment is customarily shipped with a standard finish, samples of the proposed color and finish shall be submitted for approval prior to shipping.

B. Informational Submittals:

1. Certificates: Submit the following:
   a. Certificate from paint manufacturer stating that materials meet or exceed Contract Documents requirements.
   b. Evidence of shelf life history for all products verifying compliance with the requirements of the Contract Documents.
   c. Contractor shall provide notarized statement verifying that all painting systems are compatible with surfaces specified that coatings in immersion service contain no water soluble solvents or corrosion inhibitive (active) pigments with slight water solubility. All painting systems components shall be reviewed by an authorized technical representative of paint manufacturer for use as a compatible system. Verify that all painting systems are acceptable for exposures specified and that paint manufacturer is in agreement that selected systems are proper, compatible, and are not in conflict with paint manufacturer's recommended specifications. Show by copy of transmittal form that a copy of letter has been transmitted to paint applicator.
2. Test Reports: Submit the following:
   a. Certified laboratory test reports for required performance and analysis testing in compliance with ASTM E329.
   b. Adhesion testing plan and procedures.
   c. Results of adhesion testing on existing surfaces containing paints or other coatings to be topcoated with paint systems specified. Prior to adhesion testing, submit a testing plan establishing methods, procedures and number of tests in each area where existing coatings are to remain and become substrate for painting Work. Based on results of adhesion testing, recommend methods, procedures, and painting system modifications, if necessary, for proceeding with Work.
   d. Locations of and test methods for soil sampling before beginning Work and after Substantial Completion.
   e. Proposed methods for testing, handling, and disposal of waste generated during Work.

f. Results of alkalinity and moisture content tests performed in accordance with ASTM D4262 and ASTM D4263.
g. Results of tests of film thickness, holidays, and imperfections.

3. Manufacturer's Instructions: Provide paint manufacturer's storage, handling, and application instructions prior to commencing painting Work at Site.
4. Manufacturer's Site Reports: Provide report of paint manufacturer's representative for each visit to Site by paint manufacturer's representative.
5. Special Procedure Submittals: Submit the following:
   a. Proposed protection procedures for each area of Work, explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption.
   b. Site-specific health and safety plan.
   c. Procedures for maintaining acceptable application, curing and environmental conditions during and after painting systems application.
   d. Procedures for providing adequate lighting, ventilation, and personal protection equipment relative to painting Work.
6. Qualifications: Submit qualifications data specified in Article 1.04 of this Section for the following:
   a. Applicator.
   b. Testing laboratory

C. Closeout Submittals:
   1. Maintenance Manual: Upon completion of the painting Work, furnish Architect five copies of detailed maintenance manual including the following information:
      a. Complete and updated product catalog of paint manufacturer's currently available products including complete technical information on each product. Identify product names and numbers of each product used in the painting Work.
      b. Name, address, e-mail address and telephone number of manufacturer, local distributor, applicator and technical representative.
      c. Detailed procedures for routine maintenance and cleaning.
      d. Detailed procedures for light repairs such as dents, scratches and staining.
   2. Statement of Application: Upon completion of the painting Work, submit a notarized statement to Architect signed by Contractor and painting applicator stating that Work complies with requirements of the Contract Documents and that application methods, equipment, and environmental conditions were proper and adequate for conditions of installation and use.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Product Delivery Requirements: Deliver products to Site in original, new, undamaged and unopened packages and containers, accurately and legibly and accurately labeled with the following:
   1. Container contents, including name and generic description of product.

2. Manufacturer's stock number and date of manufacture.
3. Manufacturer's name.
4. Contents by volume, for major pigment and vehicle constituents.
5. Grams per liter of volatile organic compounds.
6. Thinning instructions, where recommended.
7. Application instructions.
8. Color name and number.

B. Product Storage Requirements:
1. Store acceptable materials at Site.
2. Store in an environmentally controlled location as recommended in paint manufacturer's written product information. Keep area clean and accessible. Prevent freezing of products.
3. Store products that are not in actual use in tightly covered containers.
4. Comply with health and fire regulations of authorities having jurisdiction at Site.

C. Product Handling Requirements:
1. Handle products in a manner that minimizes the potential for contamination, or incorrect product catalyzation.
2. Do not open containers or mix components until necessary preparatory work has been completed and approved by Engineer and painting Work will start immediately.
3. Maintain containers used in storing, mixing, and applying paint in a clean condition, free of foreign materials and residue.

1.07 SITE CONDITIONS

A. Site Facilities:
1. Supplemental heat sources, as required to maintain both ambient and surface temperatures within range recommended by paint manufacturer for paint system application, are not available at Site.
2. Provision of supplemental heat energy sources, power, equipment, and operating, maintenance and temperature monitoring personnel is responsibility of Contractor.
3. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent such heat sources to exterior such that paint systems are unaffected by exhaust.

B. Environmental Requirements:
1. Apply water-base paints when the temperature of surfaces to be painted and ambient air temperatures are between 55 degrees F and 90 degrees F, unless otherwise permitted by paint manufacturer's published instructions.
2. Surfaces to be painted shall be at least 5 degrees F above dew point temperature and be dry to the touch. Apply paint only when temperature of surfaces to be painted, paint products, and ambient air temperatures are between 65 degrees F and 95 degrees F, unless otherwise permitted by paint manufacturer's published instructions.

3. Apply paint system within shortest possible time consistent with manufacturer's recommended curing instructions for each coat. If chemical, salt, or other contamination contacts paint film between coats, remove contamination per SSPC SP 1 and restore surface before applying paint.
4. Do not paint tanks or pipelines containing fluid without specific permission of Architect and only under conditions where "sweating" of outside surface of vessel being painted is not likely to occur within 24 hours of paint application.
5. Do not apply epoxy paints if ambient temperature is expected to go below 50 degrees F within twelve hours of application. Follow manufacturer's instructions when manufacturer's published recommendations require a higher minimum ambient temperature.
6. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent. Do not apply paint to damp or wet surfaces or when surfaces will reach dew point due to falling or rising temperatures and humidity conditions during course of paint application, unless otherwise permitted by paint manufacturer's published instructions.
7. Do not paint unacceptably hot or cold surfaces until such surfaces can be maintained within temperature and dew point ranges acceptable to paint manufacturer. Arrange for surfaces to be brought within acceptable temperature and dew point ranges as part of painting Work.
8. Moisture content of surfaces shall be verified to Architect as acceptable prior to commencement of painting using methods recommended by paint manufacturer.
9. Painting may be continued during inclement weather only if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer for application and drying.
10. Provide adequate illumination and ventilation where painting operations are in progress.

C. Protection:
1. Cover or otherwise protect finished work of other trades and surfaces not being painted concurrently, or not to be painted.
2. During surface preparation and painting, facility shall remain in operation. Use procedures that prevent contamination of process or cause or require facility shutdown.
3. Coordinate and schedule surface preparation and painting to avoid exposing employees of Contractor, Owner, Architect and others not involved with surface preparation and painting, to hazards associated with painting Work. Provide required personnel safety equipment per requirements of authorities having jurisdiction at Site.
4. Submit protection procedures to be employed by Contractor to Architect. Do not begin surface preparation and painting Work in any area until Architect accepts protection techniques proposed by Contractor.
5. When working with flammable materials, provide fire extinguishers and post caution signs warning against smoking and open flame.

1.08 MAINTENANCE

A. Extra Materials: Furnish, tag, and store an additional one percent by volume of all coatings and colors installed. Provide a minimum of one gallon of each coating and color. Store in unopened containers as specified until turned over to Owner.

PART 2 - PRODUCTS

2.01 PAINTING SYSTEM MANUFACTURERS

A. Products and Manufacturers: Where referenced under painting systems provide products manufactured by the following:
   1. Tnemec Company, Inc. (TCI).
   2. The Carboline Company, part of StonCor Group, an RMP Company (TCC).
   3. PPG Protective & Marine Coatings (PPG PMC).
   4. Pittsburgh Architectural Finishes (PPG PAF)
   5. Benjamin Moore & Company (BMC).
   6. ICI Paints (ICI).
   7. The Sherwin-Williams Company (SWC)

B. Product Substitutions: Proprietary protective coatings included herein by brand name or trademark are given solely as standards of quality and for bidding purposes and do not preclude the use of an approved equivalent.
   1. Equivalents: Equivalent products shall be of standard, regularly produced product of a manufacturer. Equivalent products shall be submitted on their applicable published printed literature that states the generic type, instructions for use, solids by volume, application rates, and chemical components of vehicles and solids. Equivalent products shall be accompanied by a list of projects where each of the coatings has been used on new construction and has rendered satisfactory service for at least three years. Should the manufacturer's literature of the product being offered call for higher film thickness, the greater film thickness shall be applied, and the submitted schedule shall so state.

2.02 PAINTING SYSTEMS

A. New Ferrous Metals, Structural Steel, Miscellaneous Ferrous Metals, Exterior Surfaces of Valves, Exterior Surfaces of Ferrous Piping, and Exterior Surfaces of All Ferrous Metal; Non-submerged, Interior:
   1. Surface Preparation: Refer to relevant paragraphs in Parts 1 and 3..
   2. Shop Primer:
      a. Generic Components:
         1) Minimum 66 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy coating; 300 grams per liter VOC, maximum.
         2) Products and Manufacturers: Provide one of the following:

(a) Amercoat 370 (PPG PMC); Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC): One coat, 4.0 to 6.0 dry mils.

b. Field Primer and Touch-Up:
   1) Generic Components:
      (a) Minimum 100 percent volume solids, high-build, two-component, polyamide-catalyzed epoxy; 8 grams per gallon VOC, maximum.
   2) Products and Manufacturers: Provide one of the following:
      (a) Amerlock Sealer (PPG PMC); Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC); Cor-Cote HP (SWC): One coat.

c. Finish: Gloss:
   1) Generic Components:
      (a) Minimum 80 percent volume solids, high-build, chemical-resistant, high-gloss, modified, polyamine- or polyamidoamine-catalyzed epoxy finish; 180 grams per liter VOC, maximum.
   2) Products and Manufacturers: Provide one of the following:
      (a) Amerlock 2/400 Series (PPG PMC); Series 104 H.S. Epoxy (TCI); Carboguard 890 LT (TCC); Cor-Cote HP (SWC):
         (1) Horizontal Surfaces: One coat, 6.0 to 12.0 dry mils.
         (2) Vertical Surfaces: One coat, 4.0 to 8.0 dry mils.

B. New Ferrous Metals, Non-Ferrous Metals and Exterior Surfaces of Piping; Submerged or Intermittently Submerged, including up to 4.0 above liquid surface; Interior and Exterior:
   1. Surface Preparation: Refer to relevant paragraphs in Parts 1 and 3.
   2. Factory Primer:
      a. Generic Components:
         1) Minimum 66 percent solids, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy; 334 grams per liter VOC, maximum.
      2) Products and Manufacturers: Provide one of the following:
         (a) Amercoat 370 (PPG PMC); Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC); Macropoxy HS Epoxy (SWC): One coat, 4.0 dry mils.
      b. Shop Prime/Touch-Up/Finish, Satin:
         1) Generic Components:
            (a) Minimum 80 percent volume solids, high-build, two-component, polyamide-catalyzed epoxy or polyamido-amine epoxy; 180 grams per gallon VOC, maximum.
         2) Products and Manufacturers: Provide one of the following:
            (a) Amerlock 2/400 Series (PPG PMC); Series N69 Hi-Build Epoxoline (TCI); Carboguard 890 LT (TCC); Dura-Plate UHS (SWC): Three coats, 4.0 to 15.0 dry mils, per coat.

C. New Galvanized Metal, and Fiberglass; Non-submerged, Interior:
   1. Surface Preparation: Refer to relevant paragraphs in Parts 1 and 3.

2. Primer:
    a. Generic Components:
        1) Minimum, 39 percent volume solids single-component, self-cross linking acrylic primer-sealer, 140 grams per liter VOC, maximum.
        2) Products and Manufacturers: Provide one of the following:
            (a) Pitt Tech EDF 90-812 Series (PPG PMC); Series 115 Uni-Bond DF (TCI); Galoseal Wash Primer (TCC); One coat, 2.0 to 4.0 dry mils.
    b. Finish: Satin:
        1) Generic Components:
        2) Products and Manufacturers: Provide one of the following:
            (a) Pitt Tech EDF 90-812 Series (PPG PMC); Series 116 Uni-Bond (TCI); Carbocrylic 3359 (TCC);: One coat, 2.0 to 4.0 dry mils.

D. New and Existing Aluminum in Contact with Dissimilar Materials:
    1. Surface Preparation: Refer to relevant paragraphs in Parts 1 and 3.
    2. Primer/Finish:
        a. Generic Components:
            1) Minimum 80 percent volume solids, high-build, two-component, polyamido-amine or polyamine epoxy; 180 grams per gallon VOC, maximum.
            2) Products and Manufacturers: Provide one of the following:
                (a) Amerlock 2/400 Series (PPG PMC); Series N69 Hi-Build Epoxoline 100 (TCI); Carboguard 954 HB (TCC); Dura-Plate UHS (SWC): Two coats, 4.0 to 15.0 dry mils, per coat.

E. New and Existing Concrete Masonry Block Surfaces, Interior:
    1. For use in identification of fire rated construction as indicated in Section 07841 - Firestopping.
    2. Primer-Filler:
        a. Generic Components:
            1) Minimum 50 percent volume solids, waterborne acrylic primer/sealer; 100 grams per liter VOC, maximum .
            2) Products and Manufacturers:
                (a) Environfill Series 130 (TCI); Sanitile 100 (TCC); Heavy Duty Block Filler (SWC): One coat.
        b. Finish: Satin:
            1) Generic Components
                (a) Minimum 40 percent volume solids, polyamide epoxy topcoat; 150 grams per liter VOC, maximum.
            2) Products and Manufacturers: Provide one of the following:
                (a) Hi-Build Epoxoline II Series L69 (TCI); Carboguard 894 (TCC); B73-360 Series Pro-Industrial Water-Based Catalyzed Epoxy (SWC): Two coats, 4.0 to 6.0 dry mils, per coat.
    3. Masonry Waterproof Sealer:
        a. Single component, portland cement based modified polymer coating.

b. Basis-of-Design Product: Thoroseal Plus by Sika, or approved equal.

F. New Pipe and Duct Insulation, Cloth, Paper and Canvas Jacketed; Non-submerged, Interior:
1. Surface Preparation: Refer to relevant paragraphs in Parts 1 and 3..
2. Primer:
a. Generic Components:
1) Minimum 38 percent volume solids single-component, self-cross linking acrylic primer-sealer; 159 grams per liter VOC, maximum.
2) Products and Manufacturers: Provide one of the following:
(a) Series 115 Uni-Bond DF (TCI); Sanitile 120 (TCC); (PPG PMC); One coat, 2.0 to 4.0 dry mils.
b. Finish: Satin:
1) Generic Components:
(a) Minimum 37 percent volume solids, single component, self-cross linking acrylic; 226 grams per liter VOC, maximum.
2) Products and Manufacturers: Provide one of the following:
(a) Series 1029 Enduratone (TCI); Carbocrylic 3358 (TCC); (PPG PMC); One coat, 2.0 to 4.0 dry mils.

G. New PVC and CPVC Piping and Fiberglass Insulation Covering; Non-submerged, Interior/Exterior:
1. Surface Preparation: Refer to relevant paragraphs in Parts 1 and 3.
2. Primer:
a. Generic Components:
1) Minimum 37 percent volume solids single-component, self-cross linking acrylic primer-sealer or polyamido-amine epoxy coating; 226 grams per liter VOC, maximum.
2) Products and Manufacturers: Provide one of the following:
(a) Series N69 Hi-Build Epoxoline (TCI); Sanitile 120 (TCC); One coat, 2.0 to 4.0 dry mils.
b. Intermediate:
1) Generic Components:
(a) Minimum 37 percent volume solids single-component, self-cross linking acrylic primer-sealer or polyamido-amine epoxy coating; 226 grams per liter VOC, maximum.
2) Products and Manufacturers: Provide one of the following:
(a) Series N69 Hi-Build Epoxoline (TCI); Carbocrylic 3359 (TCC); One coat, 2.0 to 4.0 dry mils.
c. Finish: Semi-Gloss/Gloss:
1) Generic Components:
(a) Minimum 59 percent volume solids, single component, Aliphatic Acrylic Polyurethane; 340 grams per liter VOC, maximum.
2) Products and Manufacturers: Provide one of the following:

(a) Series 1075U Endura-Shield II (TCI); Carbothane 130 (TCC); One coat, 2.0 to 4.0 dry mils.

2.03 INSTRUMENTS

A. Instruments:
   1. Contractor shall purchase for Owner two new dry-film thickness gauges for checking film thickness, and one set of visual standards to check surface preparation. Calibrate dry film thickness gauge at the Site using Bureau of Standards standard shim blocks. Provide one holiday detector for holiday testing. The holiday detector will remain the property of Contractor.
   2. Products and Manufacturers: Provide the following:
      a. Film Thickness Testers: Model FM-III manufactured by Mikrotest, or equal.
      b. Holiday detector shall be Model M-1 as manufactured by Tinker & Rasor, or equal.
      c. Visual Standards: ASTM D2200, Swedish Standards, SSPC VIS 1.

2.04 SNAP-ON PIPE MARKERS

A. Snap-On Pipe Markers:
   1. Wrap around labels to attach to pipe with no string, straps or adhesives.
   2. Manufacturers:
      a. Custom B-689 High Performance Pipe Markers by Brady USA, Incorporated – Signmark Division
      b. Brimar: System #1 Pipe Markers
      c. Or Equal

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine areas and conditions under which painting Work is to be performed and notify Architect in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Architect.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film capable of performing in accordance with claims made in paint manufacturer's product literature for surfaces and conditions encountered.

3.02 SURFACE PREPARATION

A. General:
   1. Test for moisture content of surfaces before commencement of painting Work. Test for moisture in concrete in compliance with ASTM D4263. Report results to Architect before commencing Work.

2. Perform preparation and cleaning procedures as specified herein and in strict accordance with paint manufacturer's approved instructions for each surface and atmospheric condition.
3. Contractor shall provide effective surface-applied protection for in place items that do not require painting prior to surface preparation and painting operations.
4. Contractor shall remove as necessary items that must be field-painted where adjacent surfaces cannot be completely protected from splatter or overspray. Following completion of painting of each space or area, the removed items shall be reinstalled by workers skilled in the trades involved.
5. Clean surfaces to be painted before applying painting system components. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning.
6. Prepare surfaces that were improperly shop-painted and abraded or rusted shop-painted surfaces as specified.

B. Cast-In-Place Concrete:
1. Prepare surfaces of concrete unit masonry to be painted by removing all efflorescence, chalk, dust, dirt, grease, oils, and other contamination using soap and water. Surfaces shall be clean and dry at time of paint system application.
2. Concrete unit masonry that cannot be adequately cleaned using soap and water shall be acid etched with a commercial solution of 15 percent muriatic acid.
3. Prepare and clean cast-in-place concrete and precast concrete surfaces per ASTM D4259 to provide a uniform and continuous anchor profile of approximately one mil. Provide mechanical abrading and abrasive blasting per ASTM D4259. Use 40 to 80-mesh abrasive and clean, dry, compressed air. Compressed air cleanliness shall be per ASTM D4285. Pressure at blasting nozzle shall not exceed 80 pounds per square inch. Do not concentrate blast on surface; instead, move at a fairly rapid rate to provide a surface free of laitants and contaminants. Provide post-surface preparation cleaning per ASTM D4258 to remove loose material. Surface preparation shall open all surface air holes by removing laitance shoulders surrounding air holes. Vacuum surfaces to remove dust and sand, and wash with potable water.
4. Where paint system is for chemical containment barrier protection, repair cracks and expansion joints in concrete and provide 2-inch radiused cove base fillets at equipment pads and containment walls as part of complete chemical containment paint system Work. Use materials and techniques recommended by manufacturers of the paint and concrete repair products.
5. Remove from cast-in-place concrete fins, projections, and other surface irregularities that would protrude above level of finished intermediate fillers and surfacers. Remove by chipping and scarification by mechanical abrasion.
6. Using specified filler and surfacer, patch cast-in-place concrete and precast concrete surfaces as required to completely fill surface air holes and honeycombing. Level all protrusions, grind filler and surfacing compounds smooth, and level with adjacent surfaces.

7. Perform tests per ASTM D4262 and ASTM D4263 to verify alkalinity and moisture content of surfaces to be painted, and report findings to Architect. If, in Architect's opinion, surfaces are sufficiently alkaline to cause blistering and burning of paint, correct the condition before applying paint. Provide suitable testing materials for alkalinity and moisture tests. Do not paint surfaces where the moisture content exceeds eight percent.
8. Where a concrete unit masonry block filler is specified, spot patch holes and cracks with a putty knife using specified block filler. Apply to large surfaces by airless spray and backroll uniformly using a roller with a synthetic nap cover. Follow with a rubber squeegee to provide a smooth finish.

C. Ferrous Metals:
   1. Ferrous Metals except Ductile and Cast Iron:
      a. Comply with paint manufacturer's recommendations for type and size of abrasive to provide a surface profile that meets manufacturer's painting system requirements for type, function, and location of surface. Verify that paint manufacturer-recommended profiles have been achieved on prepared surfaces. Report profiles to Architect using Test Method C of ASTM D4417.
      b. Clean non-submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed, of all oil, grease, dirt, mill scale, and other contamination by commercial blast cleaning complying with SSPC SP 6 at time of paint system application, using SSPC VIS 1 as a standard of comparison.
      c. Clean submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed of all oil, grease, dirt, mill scale, and other contamination by near-white blasting complying with SSPC SP 10 at time of painting system application, using SSPC VIS 1 as a standard of comparison.
      d. Clean non-submerged, ferrous surfaces that have not been shop-coated of all oil, grease, dirt, loose mill scale, and other contamination by commercial blasting complying with SSPC SP 6 at the time of painting system application, using SSPC VIS 1 as a standard of comparison.
      e. Clean submerged ferrous surfaces that have not been shop-coated or that have been improperly shop-coated of all oil, grease, dirt, mill scale, and other contamination by near-white blasting complying with SSPC SP 10 at time of painting system application, using SSPC VIS 1 as a standard of comparison.
      f. Touch-up shop-applied prime coats that have damaged or have bare areas with primer recommended by paint manufacturer after commercial blasting complying with SSPC SP 6 at the time of painting system application, using SSPC VIS 1 as a standard of comparison, to provide a surface profile of not less than one mil.
      g. Power tool-clean per SSPC SP 3 to remove welding splatter and slag.
   2. Ductile and Cast Iron:
      a. Comply with paint manufacturer's recommendations and NAPF 500-03 for type and size of abrasive to provide a surface profile meeting paint manufacturer's requirements for type, function and location of surface. Verify

that paint manufacturer-recommended profiles are achieved on prepared surfaces.

b. Clean submerged and non-submerged ductile and cast iron surfaces to be shop-primed of all oil, grease, dirt, mill scale, and other contamination by solvent cleaning and abrasive blasting complying with NAPF 500-03-01, NAPF 500-03-04, and NAPF 500-03-05 at time of paint system application.

c. Clean submerged ductile and cast iron that have not been shop-coated or that have been improperly shop-coated of all oil, grease, dirt, mill scale, and other contamination by solvent cleaning and abrasive blasting complying with NAPF 500-03-01, NAPF 500-03-04, and NAPF 500-03-05 at time of paint system application.

d. Touch-up shop-applied prime coats that are damaged or have bare areas with primer recommended by paint manufacturer, after power tooling complying with NAPF 500-03 at the time of painting system application.

D. Non-Ferrous Metal Surfaces: Prepare non-ferrous metal surfaces for painting by light whip blasting or by lightly sanding with 60- to 80-mesh sandpaper.

E. Galvanized (Zinc-Coated) Surfaces: Prepare galvanized surfaces for painting by lightly sanding with 60- to 80-mesh sandpaper or by light whip blasting.

F. PVC and CPVC Piping and Fiberglass: Lightly sand and clean surfaces to be painted. Fiberglass surfaces shall be prepared by solvent washing to remove wax and other contaminants, before abrading surfaces with 60- to 80-mesh sandpaper to provide an anchor pattern with scratches no further apart than 1/16-inch.

G. Covering on Pipe Insulation:
   1. Remove all oil and surface contaminants as recommended by paint and insulation cover manufacturer for surface and application required.
   2. Do not cut or damage insulation and covering.

3.03 PROTECTION OF PROPERTY AND STRUCTURES

A. Protect property and structures adjacent to the Work from waste residues resulting from cleaning, surface preparation and paint application.

B. Use shrouding, vacuum blasting, or other approved methods for cleaning and surface preparation of exterior surfaces.

C. During blast cleaning and surface preparation of interior and exterior surfaces, control discharge of dust and grit, using shrouding, negative-pressure containment/dust collection systems, or other means to protect adjacent property and structures and prevent dust/grit from escaping. Similarly control removal and temporary storage of residues to protect adjacent property and structures.

D. For painting of exterior surfaces, use rollers, shrouding or other approved methods as required to protect adjacent property and structures from wind-blown paint residues.

E. Submit proposed procedures for cleaning, surface preparation and paint application describing methods for protecting adjacent property and structures from residues. Do not proceed with cleaning, surface preparation or painting until proposed procedures are approved by Architect.

3.04 MATERIALS PREPARATION

A. General:
   1. Mix and prepare paint products in strict accordance with paint manufacturer's product literature.
   2. Do not mix painting materials produced by different manufacturers, unless otherwise permitted by paint manufacturer's instructions.
   3. Where thinners are required, they shall be produced by paint system manufacturer unless otherwise permitted by paint manufacturer's product literature and submitted to and accepted by Architect with Shop Drawings.

B. Tinting:
   1. Where multiple coats of the same material are to be provided, tint each undercoat a lighter shade to facilitate identification of each coat of paint.
   2. Tint undercoats to match color of finish coat of paint, but provide sufficient difference in shade of undercoats to distinguish each separate coat. Provide a code number to identify material tinted by manufacturer.

C. Mixing:
   1. For products requiring constant agitation, use methods in compliance with manufacturer's product literature to prevent settling during paint application.
   2. Mix in containers placed in suitably sized non-ferrous or oxide resistant metal pans to protect floors from slashes or spills that could stain the floor or react with subsequent finish floor material.
   3. Mix and apply paint in containers bearing accurate product name of material being mixed or applied.
   4. Stir products before application to produce a mixture of uniform density and as required during the application. Do not stir into the product film that forms on surface; instead, remove film and, if necessary, strain product before using.
   5. Strain products requiring such mixing procedures. After adjusting mixer speed to break up lumps and after components are thoroughly blended, strain through 35 to 50-mesh screen before application.

3.05 APPLICATION

A. General:
   1. Apply paint systems by brush, roller, or airless spray per manufacturer's recommendations and in compliance with Paint Application Specifications No. 1 in SSPC Volume 2, where applicable. Use brushes best suited for type of paint applied. Use rollers of carpet, velvet back, or high pile sheeps wool as recommended by paint manufacturer for product and texture required. Use air

spray and airless spray equipment recommended by paint manufacturer for specific painting systems specified. Submit a list of application methods proposed, listing paint systems and location.

2. Paint dry film thicknesses required are the same regardless of the application method. Do not apply succeeding coats until previous coat has completely dried.
3. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint, until paint film is uniform finish, color, and appearance, particularly for intense chroma primary colors. Ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a film thickness equivalent to that of flat surfaces.
4. Surfaces of items not normally exposed-to-view do not require the same color as other components of system of which they are part, but require the same painting system specified for exposed surfaces of system.
5. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint before final installation of registers or grilles.
6. Paint backs of access panels and removable or hinged covers to match exposed surfaces.
7. Paint aluminum parts in contact with dissimilar materials with specified paint system.
8. Paint tops, bottoms, and side edges of doors the same as exterior surfaces.
9. Omit field-applied primer on metal surfaces that have been primed in the shop. Touch-up paint shop-primed coats and pre-finished items only when approved by Architect using compatible primers and manufacturer's recommended compatible field-applied finishes.
10. Welds shall be stripe-coated with intermediate or finish coat of paint after application of prime coat.

B. Minimum/Maximum Paint Film Thickness:
   1. Apply each product at not less than, nor more than, manufacturer's recommended spreading rate, and provide total dry film thickness as specified.
   2. Apply additional coats of paint if required to obtain specified total dry film thickness.
   3. Maximum dry film thickness shall not exceed 100 percent of minimum dry film thickness, except where more stringent limitations are recommended by paint manufacturer for a specific product.

C. Scheduling Surface Preparation and Painting:
   1. As soon as practical after preparation, apply first-coat material to surfaces that have been cleaned, pretreated, or otherwise prepared for painting. Apply first-coat material before subsequent surface deterioration due to atmospheric conditions existing at time of surface preparation and painting. Surfaces that have started to rust before first-coat application is complete shall be brought back to required standard by abrasive blasting.
   2. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky

under moderate thumb pressure and application of another coat of paint does not cause lifting or loss of adhesion to undercoat.

3. Scarify primers and other painting system components by brush-blasting if paint has been exposed for lengths of time or under conditions beyond manufacturer's written recommendations for painting systems required, intended use, or method of application proposed for subsequent coats of paint.
4. Schedule cleaning and painting so that dust and other contaminants from cleaning process do not fall on wet, newly painted surfaces.

D. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects caused by insufficient sealing.

E. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.

F. Brush Application:
1. Brush out and work all brush coats onto surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are unacceptable. Neatly draw all glass and color break lines.
2. Brush-apply primer or first coats, unless otherwise permitted to use mechanical applicators.

G. Mechanical Applicators:
1. Use mechanical methods for paint application when permitted by governing ordinances, manufacturer, and approved by Architect.
2. Limit roller applications, if approved by Architect, to interior wall finishes for second and third coats. Apply each roller coat to provide the equivalent hiding as brush-applied coats.
3. Where spray application is used, apply each coat to provide equivalent hiding of brush-applied coats. Do not double back with spray equipment for purpose of building up film thickness of multiple coats in one pass.

H. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements as required by Architect.

3.06 FIELD QUALITY CONTROL

A. Architect may invoke the following material testing procedure at any time, and any number of times, during field painting Work:
1. Contractor shall engage service of an independent testing laboratory to sample paints used, as designated by Architect. Samples of products delivered to the Site shall be obtained, identified, sealed, and certified as to being products actually applied to the surfaces in each area, in the presence of Contractor.

2. A testing laboratory selected by Owner and paid for by Contractor shall perform appropriate tests for any or all of the following:
    a. Abrasion resistance.
    b. Apparent reflectivity.
    c. Flexibility.
    d. Washability.
    e. Absorption.
    f. Accelerated weathering.
    g. Dry opacity.
    h. Accelerated yellowness.
    i. Recoating.
    j. Skinning.
    k. Color retention.
    l. Alkali resistance.
    m. Quantitative materials analysis.
3. If the test results show that the products being used do not comply with the specified requirements, Contractor may be directed to stop painting Work and remove non-complying paint, and shall prepare and repaint surfaces coated with the rejected paint with material complying with the Contract Documents.

B. Notify Architect after completing each coat of paint. After inspection and checking of film thickness, holidays, and imperfections, and after acceptance by Architect, proceed with succeeding coat. Perform testing using testing instruments specified in Article 2.4 of this Section.
    1. Architect will witness all testing and shall be notified of scheduled testing at least twenty-four hours in advance.
    2. Apply additional coats, if required, to produce specified film thickness and to correct holidays and to completely fill all surface air holes.

C. For magnetic substrates, measure thickness of dry film nonmagnetic coatings following recommendations of SSPC PA-2. These procedures supplement manufacturers' approved instructions for manual operation of measurement gauges and do not replace such instructions.

D. Record time, location, number of coats, dry film thickness, holidays, and other imperfections and submit testing results to Architect.

3.07 PROTECTION OF NEW FINISHES

A. Provide signs that read, "Wet Paint" as required to protect newly painted finishes. Remove temporary wrappings provided for protection of the Work and work of other contractors after completion of painting.

3.08 ADJUSTING AND CLEANING

A. Correct damages to work of other trades through cleaning, repairing or replacing, and repainting, as acceptable to Architect.

B. During progress of Work, remove from Site all discarded paint materials, rubbish, cans, and rags at end of each workday.

C. Upon completion of painting, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, while avoiding scratching or otherwise damaging finished surfaces.
   1. At completion of work of other trades, touch-up and restore damaged or defaced painted surfaces as determined by Architect.
   2. The Contractor shall rectify any failures or breakdowns, loosening of the paint or coatings within a year after acceptance of work, regardless of the paint systems used. This will require the removal of the entire coating where failure occurs and repainting the coating system previously specified. Patching will not be allowed.

+ + END OF SECTION + +

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SECTION 10143

PHOTOLUMINESCENT PATH MARKINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Agreement, including General and Division 01 of the Project Manual, apply to work of this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Wall mounted photoluminescent signs as shown on drawings.

1.03 SUBMITTALS

A. Pursuant to Section 01300 - Submittals.

B. Product Data:
   1. Submit manufacturer's product data for all required components.

C. Samples:
   1. Three (3) 8" long samples of sign holder and photoluminescent sign.

D. Shop Drawings:
   1. Provide shop drawing showing all locations of signs.

E. Installation Instructions:
   1. Submit manufacturer's written installation instructions.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store strips and signs in cool, dry location until time needed for installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. American Permalight Inc., 2531 W 237th Street #113, Torrance, CA 90505 or Architect approved equivalent.

2.02 PATH MARKINGS

A. Components:
   1. Wall/Door Mounted signs.

a. Photoluminescent aluminum sign with self adhesive backing. San Serif lettering of 1-inch height minimum reading "NO EXIT" with "NO" centered above the "EXIT". The "NO" may be of a larger size than the "EXIT" for clarity. Non-luminous portion of sign shall not be green.
b. Basis-of-Design: American Permalight CC-ALU.
    1) Item No.: 6000981BC.
        (a) Size: 5" x 5"
    2) Or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this Section in accordance with the manufacturer's printed instructions and as otherwise specified.
    1. Install with the bottom edge of the marking no more than 4 inches away from the finished floor.

B. Clean substrate surfaces of dirt, oil, grease and loose matter that could impair adhesion.

C. Run full length of wall from opening to opening (door frame and/or corner guard).

D. Install photoluminescent signs at a height between 48-inches and 60-inches from the finished floor. Signs mounted on doors shall be centered in the width of the door.

+ + END OF SECTION + +

SECTION 10200

LOUVERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Provide Louvers and all associated louver accessories and components in accordance with the Contract Documents and as required to provide a complete and first class installation.

1.02 RELATED SECTIONS

A. Caulking and Sealants: Section 07920.

B. Mechanical: Division 15.

1.03 REFERENCES

A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.

B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2012 (Reapproved 2015).

C. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

D. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.04 PERFORMANCE REQUIREMENTS

A. Design and fabricate units to withstand wind lateral loads and snow loads.

B. Acoustical louvers acoustic performance shall meet that called for in Part 2.

1.05 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, tolerances; head, jamb and sill details; blade configuration, screens and frames.

C. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.

D. Samples: Submit two (2) samples, 2" x 2" in size illustrating finish and color of exterior and interior surfaces.

E. Submit two samples of manufacturer's full line of powder coating color chips. Color to be selected by Owner.

F. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

G. Equals will only be accepted if they meet or exceed the performance of specified louvers.

1.06 QUALITY ASSURANCE

A. Perform work in accordance with AMCA Certification for louvers and dampers.

1.07 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings and instructed by the manufacturer.

1.08 COORDINATION

A. Coordinate the Work with installation of flashings.

B. Coordinate the Work with installation of mechanical ductwork.

PART 2 - PRODUCTS

2.01 ACCESSORIES

A. Fasteners and Anchors: Stainless steel type.

B. Head and Sill Flashings: Roll formed to required shape, single length in one piece per location. Flashings: Of same material as louver frame.

C. Screens: Install screen mesh in shaped frame, reinforce corner construction, shop install to louver with fasteners. Screen shall be easily removed from the building interior.

D. Sealants: Type specified in Section 07920.

2.02 ACOUSTICAL LOUVERS

A. Acceptable manufacturers include:
   1. Construction Specialties model A8370 (Basis of Design).
   2. Greenheck
   3. Arrow United
   4. Nailor
   5. Approved Equal

B. Louvers shall be fabricated to provide a minimum of (23%), 3.68 square feet of free area for a 48" x 48" size louver and bear the AMCA certified ratings program seal for

air performance and water penetration. The rating shall show a beginning point of water penetration at .01 ounces per square foot of free area at a free area velocity of 887 feet per minute, with 0.08 inches of water gauge pressure drop for air intake at that free area velocity. Louvers shall have a full width sill with head and blades contained within jambs. Louver shall be approximately 8" deep.

C. Louvers shall be provided with an aluminum bird or insect screen as called for on the Equipment Schedules.

D. Frame shall be minimum 0.080" thick formed aluminum.

E. Blades shall be minimum 0.080" thick formed aluminum.

F. Acoustical insulation shall be fiberglass protected by woven 100% polyester sheeting.

G. Acoustic performance shall be tested in accordance with ASTM Standard E90-23. Transmission loss performance shall be as tabulated below:

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Transmission Loss (dB)	9	7	7	11	18	19	14	13

H. Sound transmission class (STC) shall be minimum 15.

I. Louver finish shall be two-coat 70% PVDF fluoropolymer resin, AAMA 2605 compliant finish, with integrated fluoromarine primer. Finish shall have 10-year corrosion warranty. Color as confirmed between Owner and Architect during the submittal review process.

2.03 THERMALLY INSULATED DAMPERS

A. Damper frame shall be minimum 0.080" extruded aluminum (6063-T5). Frame shall be 4" deep with mounting flanges on both sides of frame. 2" extended rear flange shall be available as an option.

B. Blades shall be maximum 6" deep extruded aluminum (6063-T5) airflow profiles.

C. Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have insulating value of R-2.29.

D. Blades shall be symmetrically pivoted.

E. Blade seals shall be extruded EPDM. Frame seals shall be extruded silicone. Seals shall be secured in an integral slot within the aluminum extrusions. Blade and frame seals shall be mechanically fastened to prevent shrinkage and movement.

F. Bearings shall be composed of a Celcon inner bearing fixed around a 7/16" aluminum hexagon blade pivot pin rotating within a polycarbonate outer bearing inserted in the frame to eliminate action between metal-to-metal or metal-to-plastic riding surfaces.

G. Adjustable 7/16" hexagonal drive rod, u-bolt fastener, and hexagonal retaining nuts shall be zinc-plated steel and shall provide a positive connection to blades and linkage.

H. Aluminum and zinc-plated steel linkage hardware shall be installed in the frame side, complete with cup-point trunnion screws for slip-proof grip.

I. Dampers shall be designed for operation in temperatures ranging from -40°F to 212°F.

J. Dampers shall have Leakage Class 1A (maximum leakage 3 cfm/ft2 at 1 inch water gauge static pressure differential). Leakage shall be certified under the AMCA Certified Ratings Program.

K. Dampers shall be custom made to the required size, without blanking off free area. The blade stop shall be set at a fixed height and shall be a continuous part of the top and bottom frames.

L. Dampers shall be parallel blade action.

M. Dampers shall be Series 9000 Thermally Insulated Dampers by Tamco or approved equal.

2.04 MOTORIZED DAMPER ACTUATORS

A. Actuator shall be powered open, spring closed (fail closed); or spring open, power closed (fail open) as called for on the Equipment Schedules.

B. Actuator shall have die cast aluminum housing and plastic casing. Enclosure shall meet UL Enclosure Type 4.

C. Actuators shall be provided by the Damper Vendor to match the torque requirement of the Dampers as determined by the Damper/Actuator Vendor.

D. Actuators shall have two (2) SPDT auxiliary switches.

E. Electrical requirements shall be as called for on the Equipment Schedules.

F. Motorized actuators acceptable manufacturers include Belimo, Honeywell, and Johnson Controls.

2.05 MOTORIZED DAMPER WHISKER (PROOF) SWITCHES

A. Whisker switches are covered in 15905 - Instrumentation and Control Integration for HVAC Systems.

2.06 INSULATED LOUVER BLANK OFF PANELS

A. 3-Inch thick, custom fabricated blank off panels with fully sealed perimeter.

B. Facing: 0.032 inch thick aluminum on both sides.

C. Perimeter Frame: 0.050 inch thick-formed aluminum channels with mitered corners.

D. Core: fire rated mineral wool insulation, R-4 per inch minimum.

E. Finish: Kynar 500 minimum 1-mil thick full strength, 70% fluoropolymer coating.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that prepared openings and flashings are ready to receive work and opening dimensions are as indicated on shop drawings and instructed by the manufacturer.

3.02 INSTALLATION

A. Install louver assembly in accordance with manufacturer's instructions, including intermediate structural support/mullions as instructed by the manufacturer.

B. Install louvers level and plumb.

C. Install flashings and align assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
   1. Provide 4" high by full depth flashing of 0.050" aluminum minimum. Sill flashing shall have welded end dams.

D. Secure louvers in opening framing with concealed fasteners.

E. Install screens and frame to interior of louver where indicated.

F. Install perimeter sealant and backing rod in accordance with Section 07920.

G. Provide intermediate structural support for dampers that consist of two or more sections.

H. Portions of louvers not required to be functional shall be provided with insulated blank-off panels as called for on the Drawings. Install insulated louver blank-off panels independently to rear side of louver without penetrating any part of the primary sealing sheet.

3.03 ADJUSTING AND CLEANING

A. Test operable dampers and adjust as needed to produce fully functioning units that comply with the requirements.

B. Clean exposed louver surfaces that are not protected by temporary covering to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces in accordance with manufacturer's directions.

D. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect/Engineer, remove damaged units and replace with new units.

E. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

+ + END OF SECTION + +

SECTION 10400

IDENTIFICATION DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install identification devices.
      a. General Contractor shall be responsible for all identification devices throughout the Project as shown and as specified herein.
      b. Extent of identification devices is shown and, where indicated, as specified.
      c. Types of products required include the following:
         1) Room identification, information, entry and directional signs.
         2) Health, safety, warning, and fire extinguisher location signs.
         3) Pipeline identification signs, tags, and equipment nameplates.
         4) Stainless steel fasteners, supports, very-high-bond high-performance mounting tape, primers and other accessories.
   2. Coordination:
      a. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the identification devices.
      b. Coordinate adhesives and fasteners with mounting surfaces. Review other Sections in order to ensure compatibility of identification device mounting accessories for the various surfaces.
   3. Related Sections:
      a. Section 09900, Painting.

1.02 REFERENCES

A. Standards referenced in this Section or referenced in Product Performance Standards are listed below:
   1. AA SAA-46, Standards for Anodized Architectural Aluminum.
   2. AA DSA-45, Designation System for Aluminum Finishes.
   3. ANSI A13.1 Scheme for the Identification of Piping Systems.
   4. ANSI A117.1, Accessible and Usable Buildings and Facilities.
   5. ANSI Z535.1, Safety Color Code.
   6. ANSI Z535.2, Environmental and Facility Safety Signs.
   7. ANSI Z535.3, Criteria for Safety Symbols.
   8. ANSI Z535.4, Product Safety Signs and Labels.
   9. ANSI Z535.5, Accident Prevention Tags (for Temporary Hazards).

10. ASTM A 167, Specification for Stainless and Heat-Resisting Chromium -Nickel Steel Plate, Sheet, and Strip.
11. ASTM E 527, Practice for Numbering Metals and Alloys (UNS).
12. CAS Registry Numbers for Specific Chemical Identity.
13. CDA, Properties of Cast Copper Alloys.
14. NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
15. OSHA 1970, Title 29, Code of Federal Regulations Part 1910.1200, Hazard Communication Standard.
16. OSHA 1970, Title 29, Code of Federal Regulations Part 1910, Subpart Z, Toxic and Hazardous Substances.
17. OSHA 1970, Title 29, Code of Federal Regulations Part 1910.144, Safety Color Code for Marking Physical Hazards.
18. OSHA 1970, Title 29, Code of Federal Regulations Part 1910. 145, Specification for Accident Prevention Signs and Tags.

1.03 QUALITY ASSURANCE

A. Identification Devices Manufacturers:
   1. Engage firms specializing in the production of the types of products specified, in compliance with specified standards, with a documented record of successful in-service performance, and who can provide sufficient production capacity to avoid delaying the Work.
   2. Submit name and experience record of manufacturers to Engineer.

B. Component Supply and Compatibility:
   1. Obtain each separate type of identification device from a single supplier and from a single manufacturer.
   2. Colors shall be brilliant, distinctive shades, matching the safety colors specified in ANSI Z535.1 and OSHA 1910.144.

C. Requirements of Regulatory Agencies:
   1. All accident prevention signs and tags shall comply with OSHA 1910.145.
   2. All health, safety and warning signs shall comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3 and OSHA 1910.144 and 1910.145, unless otherwise specified. The colors shall be those of opaque glossy samples as specified in Table 1 of ANSI Z535.1. Safety symbol pictograms shall be incorporated into each sign, in addition to text.

D. Codes: Comply with applicable requirements of International Building Code.

1.04 SUBMITTALS

A. Samples: Submit the following:
   1. Each color and finish of exposed materials and accessories required for identification devices.

2. Actual full-size sample of each type of permanent room identification sign and informational and directional sign incorporating all features specified; pipeline identification sign and mounting accessories; equipment and structure nameplate, valve tags and accessories; and right-to-know signs, labels and tags. Stamp valve tag with information shown on valve schedules. Information on the type of coding system will be furnished to Contractor by Engineer.
3. Engineer's review of samples will be for color and texture only. Compliance with all other requirements is the responsibility of Contractor.
4. List of spare parts recommended by the manufacturer. The list shall describe each part, the quantity recommended, and the unit price of each part.

B. Shop Drawings: Submit the following:
1. Copies of manufacturer's technical data for each product specified including fabrication and erection information for all identification devices. Show anchorages and accessory items. Furnish location template drawings for items supported or anchored to permanent construction.
2. Complete selection of each specified manufacturer's standard and custom colors, alphabetic styles, graphic layouts and pictograms.
3. Coordinate mounting position, method, and proposed mounting accessories and fasteners with actual Project conditions. Indicate required mounting accessories on plans showing locations of all required exit signs based on measurements taken at the Site. Show final location and identify type of mounting surface for each exit sign. Coordinate location of exit signs for non-interference with other Work and as required by governing authorities having jurisdiction at the Site.

1.05 PROJECT CONDITIONS

A. Field Measurements:
1. Verify dimensions in areas of installation. Take measurements at the Site before fabrication and indicate dimensions on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
2. Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to dimensions established for identification devices Work.

B. Scheduling:
1. Coordinate the delivery of templates, instructions and directions for installation of anchorage devices with other Work to avoid delay.

PART 2 - PRODUCTS

2.01 SYSTEM PERFORMANCE

A. Performance Criteria:

1. Details for identification devices shown, such as alphabet representation, letter spacing, borders designs, and other graphic features, are generic and intended to establish text, general positions and symbols only.
2. Contractor shall submit for approval complete, camera-ready, color graphic layouts based on specified requirements and recommendations from manufacturer.

B. Allowable Tolerances:
1. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16-inch measured diagonally.

2.02 ROOM IDENTIFICATION, INFORMATION, ENTRY AND DIRECTIONAL SIGNS

A. Product Description: Provide unframed signs, surface-etched, 1/32-inch raised tactile lettering and pictograms, sandblasted on an opaque 3-ply laminate of self-extinguishing melamine plastic sheet with a non-glare surface and phenolic core.

B. Size and Thickness: 0.125-inches thick; 8-inches by 8-inches with 1/2-inch radiused corners.

C. Exposure: Recommended by the manufacturer for interior and non-direct sun exterior use and acceptable for continuous operating temperatures of 225°F.

D. Graphics and Alphabet: White, Standard Helvetica Medium alphabet and matching arrow type-face; upper and lower case 1-inch high capitals.

E. Colors and Contrast: Background of signs shall be eggshell, matte or other non-glare finish. Characters and symbols shall contrast by at least 70 percent with their background as determined by ADA formula in ADAAG Appendix A4.30.5.

F. Products and Manufacturers: Provide one of the following:
1. Graphic Blast HC-200 ADA System and Custom Design ADA Series by Best Manufacturing Sign Systems, Incorporated.
2. ASI Signs Systems, Inc.
3. Or equal.

2.03 HEALTH, SAFETY, WARNING, AND FIRE EXTINGUISHER LOCATION SIGNS

A. Product Description: Provide rigid fiberglass reinforced plastic signs with fade-resistant embedded graphics.

B. Size and Thickness: 0.125-inches thick; 10-inches by 14-inches, unless otherwise specified.

C. Graphics and Alphabet: Standard Helvetica Medium alphabet and matching arrow type-face; upper and lower case 1-inch high capitals.

D. Exposure: Recommended by the manufacturer for both indoor and outdoor use and with a upper service temperature limit of 190°F. Average durability for outdoor use shall be 15 years.

E. Safety Instruction Signs: Standard color of the background shall be white; and the panel, green with white letters. All letters used against the white background shall be black.

F. Caution Signs: Standard color of the background shall be yellow; and the panel, black with yellow letters.

G. Danger Signs: Standard color of the background shall be white; and the panel black with red insert containing white letters. All letters used against the white background shall be black.

H. Warning Signs: Standard color of the background shall be orange; and the panel black with orange insert containing black letters. All letters used against the orange background shall be black.

I. Notice Signs: Standard color of the background shall be white; the panel shall be blue with white letters. All letters used against the white background shall be black.

J. No Smoking Signs: Standard color of the background shall be white. All letters used against the white background shall be red.

K. Biohazard Signs: Standard color of the background shall be white; and the panel black with white letters. Incorporate red international biohazard pictogram on white background.

L. Floor Loading Signs: Standard color of the background shall be white; and the panel blue with white letters. All letters used against the white background shall be black.

M. Fire Extinguisher Location Signs (surface-mounted units only): Standard color of the background shall be red with white letters. Each sign shall incorporate an international fire extinguisher pictogram and a directional arrow indicating location of fire extinguisher.

N. Auxiliary Products:
   1. Mounting Brackets: Provide manufacturer's standard mounting brackets for hanging, projected or double-sided signs.

O. Products and Manufacturers: Provide one of the following:
   1. Graphic Blast Word and Picture Series by Best Manufacturing Sign Systems, Incorporated.
   2. ASI Signs Systems, Inc.
   3. Or approved equal.

2.04 PIPELINE IDENTIFICATION SIGNS

A. Pipeline Identification Signs:
   1. Lettering of Titles:
      a. Letter size shall be as indicated in the following table:

LETTER SIZE TABLE

Outside Diameter of Pipe or Covering*	Size of Legend Letters
3/4-inches to 1-1/4 inches	1/2-inches
1-1/2-inches to 1-7/8--inches	3/4-inches
2-inches to 5-7/8-inches	1-1/4-inches
6-inches to 9-7/8-inches	2-1/2-inches
10-inches and Over	3-1/2-inches

*Outside diameter shall include pipe diameter plus insulation and jacketing.

      a. Text and symbols shall be Standard Helvetica Medium, all upper case. Signs shall include text with separate arrow signs indicating direction of flow and be located as specified in Part 3 of this Section.
   2. Sign Materials: Provide the following:
      a. Signs shall be coiled construction, polyester with ultraviolet light-resistant, sealed, subsurface color graphics, recommended by the manufacturer for both indoor and outdoor use and for service temperature range from -40 degrees F to 248 degrees F.
      b. Provide manufacturer's full selection of standard and custom sizes, colors and graphics. Where manufacturer has established minimum order quantities for custom units provide minimum order quantities at no additional cost to Owner.
      c. Where large pipe diameters preclude overlap of pipeline sign material, provide Type 304, 1/4-inch wide stainless steel banding straps; two per sign, lengths as required by circumference of pipe or covering. Provide manufacturer's recommended banding tools for stainless steel banding.
   3. Legend for Pipeline Identification Signs: Pipeline identification signs shall have the following text or abbreviations in the color combinations designated to identify the pipeline service.

TABLE 10400-B, SCHEDULE OF PIPE MARKERS*		
PIPELINE LEGEND	**LETTERING/TEXT COLOR**	**BACKGROUND COLOR**
WATER		

AIR CONDITIONING WATER	WHITE	GREEN
BACKWASH WATER	WHITE	GRAY
BEARING COOLING WATER	WHITE	GREEN
CHILLED WATER RETURN	WHITE	GREEN
CHILLED WATER SUPPLY	WHITE	GREEN
CIRCULATING WATER	WHITE	GREEN
CITY WATER	WHITE	GREEN
CLARIFIED WATER	WHITE	GREEN
COLD WATER	WHITE	GREEN
CONDENSER WATER	WHITE	GREEN
COOLING WATER	WHITE	GREEN
DANGEROUSLY HOT WATER (__°F)	WHITE	GREEN
DEIONIZED WATER	WHITE	GREEN
DILUTION WATER	WHITE	GREEN
DISTILLED WATER	WHITE	GREEN
DOMESTIC HOT WATER	BLACK	YELLOW
DRINKING WATER	WHITE	GREEN
EFFLUENT WATER	WHITE	GRAY
ENGINE JACKET WATER	WHITE	GREEN
ENGINE COOLING WATER	WHITE	GREEN
FILTERED WATER	WHITE	GREEN
FINISHED WATER	WHITE	GREEN
FIRE WATER	WHITE	RED
FLUSHING WATER	WHITE	GREEN
HIGH PRESSURE WATER (__PSI)	WHITE	GREEN
HOT WATER RETURN (__°F)	WHITE	GREEN
HOT WATER SUPPLY (__°F)	WHITE	GREEN
HYDRAULIC CONTROL WATER	WHITE	GREEN
ICE WATER	WHITE	GREEN
MAKE-UP WATER	WHITE	GREEN
NON-POTABLE WATER	WHITE	GREEN
PLANT WATER	WHITE	GREEN
POTABLE WATER	WHITE	GREEN
PUMP FLUSHING WATER	WHITE	GREEN
RAW WATER	WHITE	GRAY
RIVER WATER	WHITE	GRAY
SEAL WATER	WHITE	GREEN
SETTLED WATER	WHITE	GRAY
SLUDGE HEATING WATER	WHITE	GREEN
SPRINKLER WATER	WHITE	RED
STANDPIPE WATER	WHITE	RED

TREATED WATER	WHITE	GREEN
UNSAFE WATER	WHITE	GRAY
WASTE WATER	BLACK	ORANGE
WELL WATER	WHITE	GREEN
STEAM		
EXHAUST STEAM	BLACK	WHITE
HIGH PRESSURE STEAM	BLACK	WHITE
LOW PRESSURE STEAM	BLACK	WHITE
MEDIUM PRESSURE STEAM	BLACK	WHITE
AIR AND GAS		
ARGON	WHITE	PURPLE
ACETYLENE	BLACK	YELLOW
AMMONIA	BLACK	YELLOW
BLOWER AIR	WHITE	BLUE
BUTANE	WHITE	BROWN
CARBON DIOXIDE	WHITE	PURPLE
CHLORINE GAS	BLACK	ORANGE
COMPRESSED AIR	WHITE	BLUE
CITY GAS	WHITE	BROWN
DEFOAMANT	WHITE	PURPLE
ENGINE AIR	WHITE	BLUE
EXHAUST SILENCER BLOWOFF	WHITE	BLUE
FREON	BLACK	YELLOW
FUEL GAS	WHITE	BROWN
FURNACE STACK GAS	BLACK	ORANGE
HELIUM	WHITE	PURPLE
HIGH PRESSURE AIR	WHITE	BLUE
HIGH PRESSURE NATURAL GAS	WHITE	BROWN
HYDROGEN	WHITE	YELLOW
INERT GAS	WHITE	PURPLE
INSTRUMENT AIR	WHITE	BLUE
INTAKE AIR	WHITE	BLUE
LOW PRESSURE AIR	WHITE	BLUE
LOW PRESSURE NATURAL GAS	WHITE	BROWN
MIXED GAS	BLACK	ORANGE
NATURAL GAS	WHITE	BROWN
NITROGEN	WHITE	PURPLE

OXYGEN	BLACK	YELLOW
OZONE	BLACK	ORANGE
PROPANE GAS	WHITE	BROWN
SERVICE AIR	WHITE	BLUE
SOOT BLOWER AIR	WHITE	BLUE
SLUDGE GAS, H.P.	WHITE	BROWN
SLUDGE GAS, L.P.	WHITE	BROWN
STARTING AIR	WHITE	BLUE
WASTE GAS	BLACK	YELLOW
FUELS AND LUBRICANTS		
BLOWER LUBE	BLACK	YELLOW
DIESEL FUEL OIL	WHITE	BROWN
ENGINE LUBE	BLACK	YELLOW
FUEL OIL	WHITE	BROWN
GASOLINE	BLACK	YELLOW
GREASE	BLACK	YELLOW
HIGH PRESSURE LUBE OIL	BLACK	YELLOW
HYDRAULIC FLUID	BLACK	YELLOW
KEROSENE	WHITE	BROWN
LUBE OIL	BLACK	YELLOW
LUBE OIL FILL	BLACK	YELLOW
VACUUM	WHITE	PURPLE
WASTE OIL	BLACK	YELLOW
CHEMICALS		
ACETONE	BLACK	YELLOW
ACID	BLACK	ORANGE
ALUM	BLACK	ORANGE
AMMONIA	BLACK	ORANGE
CARBON	BLACK	ORANGE
CARBON SLURRY	BLACK	ORANGE
CAUSTIC	BLACK	ORANGE
CAUSTIC SODA	BLACK	ORANGE
CHLORINE LIQUIFIED	BLACK	ORANGE
CHLORINE SOLUTION	BLACK	ORANGE
FERRIC CHLORIDE	BLACK	ORANGE
FLUORIDE	BLACK	ORANGE
HYDROGEN PEROXIDE	BLACK	ORANGE
LIME	BLACK	ORANGE
LIME SLURRY	BLACK	ORANGE
NEAT (BULK) POLYMER	BLACK	ORANGE

POLYMER SOLUTION	BLACK	ORANGE
POLYELECTROLYTE SOLUTION	BLACK	ORANGE
POTASSIUM PERMANGANATE	WHITE	ORANGE
SULFUR DIOXIDE	BLACK	ORANGE
SODIUM HYPOCHLORITE	BLACK	ORANGE
PROCESS		
ASH CONVEYING AIR	BLACK	ORANGE
ASH WATER	BLACK	ORANGE
CENTRATE	BLACK	ORANGE
CLARIFIER DRAINS	BLACK	ORANGE
COMBINED SLUDGE	BLACK	ORANGE
CONCENTRATION TANK DRAINS	BLACK	ORANGE
CONCENTRATION TANK OVERFLOW	BLACK	ORANGE
DIGESTER TANK OVERFLOW	BLACK	ORANGE
DIGESTED SLUDGE	BLACK	ORANGE
DIGESTER TANK DRAINS	BLACK	ORANGE
DISINFECTANT	BLACK	ORANGE
EXCESS ACTIVATED SLUDGE	BLACK	ORANGE
FILTRATE	BLACK	ORANGE
FLOOR DRAINS	BLACK	GRAY
FLY ASH	BLACK	ORANGE
GRAVITY THICKENER OVERFLOW	BLACK	ORANGE
GRIT	BLACK	ORANGE
MIXED LIQUOR	BLACK	ORANGE
MIXED SLUDGE	BLACK	ORANGE
MODIFIED SLUDGE	BLACK	ORANGE
PRIMARY SLUDGE	BLACK	ORANGE
RAW SLUDGE	BLACK	ORANGE
RECIRCULATED DIGESTER SLUDGE	BLACK	ORANGE
RETURN ACTIVATED SLUDGE	BLACK	ORANGE
SCAVANGER WASTE	BLACK	ORANGE
SCRUBBER DRAINS	BLACK	ORANGE
SCUM	BLACK	ORANGE
SECONDARY SLUDGE	BLACK	ORANGE
SETTLING TANK DRAINS	BLACK	ORANGE
SEWAGE	BLACK	ORANGE
SEWAGE SAMPLING LINE	BLACK	ORANGE

SKIMMINGS	BLACK	ORANGE
SLUDGE	BLACK	ORANGE
SODA ASH	BLACK	ORANGE
CHEMICAL STORAGE TANK DRAINS	BLACK	ORANGE
CHEMICAL STORAGE TANK OVERFLOW	BLACK	ORANGE
STORM DRAINS	WHITE	GRAY
SUMP DRAINS	WHITE	GRAY
SUPERNATANT	BLACK	ORANGE
THICKENER OVERFLOW	BLACK	ORANGE
THICKENER EFFLUENT LINE	BLACK	ORANGE
THICKENED SLUDGE	WHITE	ORANGE
THICKENER TANK DRAINS	WHITE	ORANGE
THICKENER TANK VENT	WHITE	GRAY
WASTE ACTIVATED SLUDGE	BLACK	ORANGE
WET ASH	BLACK	ORANGE
WASTE BACKWASH	WHITE	GRAY
WASTEWATER	BLACK	ORANGE
VENTS		
CONCENTRATION TANK VENT	BLACK	ORANGE
DIGESTER TANK VENT	BLACK	ORANGE
THICKENER TANK VENT	BLACK	ORANGE

B. Products and Manufacturers: Provide one of the following:
   1. See Section 09900 for Pipe Markers.

2.05 EQUIPMENT NAMEPLATES

A. Description:
   1. Provide a minimum of 50 equipment nameplates for equipment furnished under the Contract, and for other equipment items indicated to receive nameplates as directed by the Engineer. Equipment nameplates specified in this Article are in addition to equipment manufacturer's standard nameplate with manufacturer name, model number, serial number, and similar information.
   2. Install equipment nameplates as indicated in Part 3 of this Section. Mechanically fasten equipment nameplates to the associated equipment item.

B. Products and Manufacturers: Provide one of the following:
   1. Brady-Etch Stainless Steel ID Tags (B-748) custom engraved, by Brady Worldwide, Inc.,

2. Custom Screen printed Nameplates – Stainless Steel, by Seton Identification Products, a Tricor Direct Company
3. Or approved equal.

C. Equipment Nameplates:
1. Material: Type 304 or Type 316 stainless steel with 0.0015-inch thick black enamel background or black screen-printed background, 26-gauge thick with rounded corners. Provide nameplates with screen-printed background installed outdoors with acrylic overcoat. Suitable for temperatures ranging from -40 to 89 degrees C.
2. Provide each equipment nameplate with not less than two holes, each approximately 3/16-inch diameter, for mechanically fastening nameplate to the associated equipment. Provide appropriate stainless steel fasteners.
3. Nameplate Size:
   a. Size shall be as required for required text, and shall be not less than one-inch by four inches.
4. Text Engraved on Nameplates:
   a. Text Size: Equipment nameplate titles shall have text as large as possible to fit on nameplate; text shall be not less than 1/2-inch high. All text on a given nameplate shall be one size.
   b. Text and symbols shall be Standard Helvetica Medium, all upper-case.
   c. Left-justify multiple lines of text
   d. Where more than one item of the same type of equipment is furnished, consecutively number each associated equipment nameplates as shown or indicated; for example “Pump No. 1”, “Pump No. 2”, “Pump No. 3”, and so on.

D. Operating Stands for Valves and Gates:
1. Nameplate material, size, and text requirements are the same as indicated above for other equipment nameplates.
2. Operating stands for valves and gates shall carry the respective legends “V. No. ___” or “S.G. No. ___,” with the appropriate equipment number to be indicated by Engineer.
3. Background and text color of nameplates for valve and gate operators shall be the same colors specified above for other equipment nameplates.
4. Background and text color of nameplates for valves and gates shall be the same as for the associated pipe markers.

2.06 VALVE AND PIPELINE TAGS

A. Metal Tags:
1. For all valves and pipelines larger than 2 inches in diameter provide permanently legible metal tags, 2-inch diameter round, Type 304 stainless steel tags with engraved lettering filled with black enamel. Provide all valve tags with a 3/16-inch diameter hole located so as not to interfere with legend.
2. Legend for Valve Tags:

a. Based on information provided on the Drawings, Contractor shall submit to Engineer, no less than 30 days before start-up, a Valve Schedule containing all required valves.
b. The Valve Schedule shall contain for each valve, the location, type, a number, words to identify the valve's function, type of operator and the normal operating position.
c. Each valve shall be coded and identified by Engineer utilizing a combination of up to twelve letters and numbers.

3. Miscellaneous Valve and Small Pipeline Tag Accessories:
   a. Stainless Steel Wire: Nylon coated; outside diameter 0.048-inches.
   b. Clamps: Brass.
   c. Hand Sealing Press: As recommended by tag manufacturer for crimping lead seals.

B. Products and Manufacturers: Provide one of the following:
   1. Custom Engraved Stainless Steel Valve Tags by NapTags, 800-451-3330 Grand Rapids, MI
   2. Custom Engraved Stainless Steel Valve Tags by Brady USA, Incorporated, Signmark Division.
   3. Or approved equal.

2.07 SITE ENTRY, DIRECTIONAL AND INFORMATION SIGNS

A. Fiberglass sheets, 1/8-inch thick minimum, bonded to a extruded aluminum internal structure, to form a seamless monolithic sign panel. Provide the following:
   1. Posts: Four-inch diameter 6063-T52 alloy extruded aluminum round posts notched to receive sign panel. Provide posts height of 6 foot-0 inches above finished grade.
   2. Finish: Two coats of colored polyurethane and one coat of clear polyurethane; factory applied to posts and sign panels. Provide complete selection of manufacturer's standard and custom colors.
   3. Graphics: Subsurface, photo-mechanically incorporated utilizing an integral graphic process
   4. Color: Engineer may select a maximum of three colors, in addition to white and black. All three colors and city logogram, in addition to white and black, will appear on each sign.
   5. Letter Style: Match existing with matching directional arrows.

B. Products and Manufactures: Provide one of the following:
   1. 821 FR Series by ASI Sign Systems, Incorporated.
   2. Fabricated Site Signs by Nap Tags, Grand Rapids, MI.
   3. Or approved equal.

2.08 LIFE SAFETY SIGNAGE:

A. Sign with smooth, uniform surfaces; with message and characters and graphics having uniform faces, sharp corners, and precisely formed lines and profile..

B. Provide the following signage as indicated on the drawings and as required by the AHJ:
   1. Exit signs.
   2. In Case of Fire - Use Stairways.
   3. Stairwell Identification signage at each level.
   4. Tactile Floor Level Signage.
   5. Fire Door signage - "Do Not Block" / "Keep Closed"
   6. No Exit signage.
   7. Evacuation Map signage (located as directed by AHJ and based on a scale floor plan graphic for each building level) with the following graphics:
      a. "You are Here"
      b. Primary and Secondary Exit routes
      c. Exit Doors and Stairwells.
      d. Fire Extinguisher, Fire Pull, First Aid and AED locations.
      e. Legend for all graphics.

2.09 AUXILIARY MATERIALS

A. Very-High-Bond High-Performance Bonding Tape:
   1. Provide all surface-mounted identification devices with very-high-bond foam tape backing except where specifically specified as requiring mechanical fasteners.
   2. Provide a very-high-bonding pressure sensitive joining system consisting of double-coated conformable acrylic foam tape and release liners:
   3. Thickness: 0.045-inch.
   4. Tape Width: 1-1/2-inches.
   5. Color: Dark grey.
   6. Bonding Adhesive: Acrylic; very-high-bond, solvent and shear resistance.
   7. Primer: High-performance tape manufacturers recommended acrylic primer.
   8. Products and Manufacturers: Provide one of the following:
      a. Scotch Brand (Very-High-Bond) 4942 VHB Double Coated Acrylic Foam Tape and No. 94 Acrylic Primer by 3M Industrial Tape and Specialties Division.
      b. Or approved equal.

B. Mounting Brackets: Provide manufacturer's standard mounting brackets for hanging, projected or double-sided signs.
   1. Furnish inserts, and mechanical and adhesive anchoring devices as specified for the installation of identification devices.

C. Fasteners: Provide fasteners of non-magnetic stainless steel of size and type required and recommended by individual identification device manufacturers.

D. Anchors and Inserts: Use nonferrous metal or hot-dipped galvanized anchors and inserts. Use toothed stainless steel or lead expansion bolts for drilled-in-place anchors.

2.10 FABRICATION

A. Shop Assembly:
   1. Fabricate and preassemble items in the shop to the greatest extent possible.
   2. Disassemble units only to the extent necessary for shipping and handling limitations.
   3. Clearly mark units for reassembly and coordinated installation.

2.11 INDIVIDUAL DIMENSIONAL CAST CHARACTERS

A. Provide individual cast metal letters and numbers with smooth, flat faces, sharp corners, true lines, and accurate profiles.

B. Products and Manufacturers: Provide one of the following:
   1. Cast Bronze Individual Letters and Numbers, by Gemini, Inc.
   2. Cast Bronze Individual Letters and Numbers, by Visigraph Corporation.
   3. Or approved equal.

C. Material:
   1. Bronze, Copper Development Association Designation Alloy, UNSC83450; 88 percent copper, 2.5 percent tin, two percent lead, 6.5 percent zinc and one percent nickel, in accordance with ASTM E527; with dark statuary bronze oxidized CDA-M31C5506x finish produced using aqueous sulfide conversion chemical.
   2. Provide letters and numbers with both faces and edges with satin finish.
   3. Provide integral cast lugs in the back of letters and numbers and tap to receive threaded mounting studs.

D. Style and Height: To match existing.

E. Mounting: Provide each letter and number with not less than two 4-inch long by 1/8-inch diameter threaded bronze studs.

F. Provide the following individual dimensional cast letters and numbers located where shown or indicated:
   1. Blower Building (Location - Bay Park).

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor and his installer shall examine the substrates and conditions under which the identification devices are to be installed and notify Engineer, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the

Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.02 INSTALLATION

A. General:
   1. Install identification devices and components as directed by Engineer, securely mounted with concealed very-high-bond acrylic foam tape or mechanical/chemical fasteners where specified. Attach signs to surfaces in accordance with the manufacturer's instructions, unless otherwise shown. Installation of signs to railings is to match existing field conditions.
   2. Mount exit signs in locations shown. Surface mount signs above all exit doors, unless otherwise shown.
   3. Contractor shall install paper version of approved identifying devices at locations indicated on drawings, tables, and as directed by the Engineer and Authority of Jurisdiction to accept prior to installation of approved identifying devices.
   4. Install level, plumb, and at the proper height. Repair or replace damaged units as directed by Engineer.
   5. Install very-high-bond acrylic foam tape on back of identification devices using a full perimeter of specified tape. Leave no gaps in tape perimeter at back of identification devices; peel off second release liner and press onto surfaces.
   6. Install level, plumb, and at the specified height.

B. Room Identification, Directional and Information Signs:
   1. Where permanent identification is provided for rooms and spaces, install signs on the wall adjacent to the latch side of the door.
   2. Where there is no wall space on the latch side of the door, including at double leaf doors, install signs on the nearest adjacent wall.
   3. Mounting height shall be 5 feet - 0 inches above the finish floor to the centerline of the sign. Mount such signage so that a person may approach within 3-inches of the sign without encountering protruding objects or, when reading sign, be forced to stand within the swing of a door.

C. Pipe and Equipment Identification Signs, Name-plates and Tags:
   1. The name of the materials in each pipeline and, alongside this, an arrow indicating the direction of flow of fluids, shall be indicated on each pipeline system.
   2. Titles shall not be located more than 30 linear feet apart and shall also appear
   3. directly adjacent to each side of all walls penetrated by pipeline, adjacent to each side of all valve regulators, flowcheck, strainer cleanouts, and all pieces of equipment. Arrows shall be located at intervals not to exceed 15 linear feet apart.
   4. Titles shall identify contents by complete name. Identification title locations shall be determined by Engineer, but in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering when they are overhead. Title shall be clearly visible from operating positions especially those adjacent to control valves.

5. Signs on large valves shall be located on or adjacent to the valve itself. Tags for smaller valves shall be attached to bonnet or flange bolts. Do not attach tags or signs to handwheels of valves.
6. Locate nameplates on equipment bases and on structures at readily visible levels in such positions relative to the equipment and structures as to prevent damage to the nameplate.

D. Right-To-Know Signs, Labels and Tags:
1. Locate tags at 20 feet maximum center to center distance along chemical pipelines and fill pipelines and on each side of all locations where pipes emerge from penetrations with other materials.
2. Install tank signs on all tanks shown to receive signage at quarter-points on tank circumference, 5 foot - 0 inches above finished floor.

3.03 PROTECTION AND CLEANING

A. After installation, clean soiled identification device surfaces according to manufacturer's instructions.

B. Protect units from damage until Final Completion by Owner.

3.04 GENERAL SCHEDULE

A. See drawings for signage locations.

Type	Message	Pictogram	Notes
A	Stair, with floor level indication	Yes	Provide 1 sign per level at each stair.
B	Room number and name	No	Provide 1 sign at each room as indicated on the drawings.
C	Room Number	No	Provide 1 sign at each room as indicated on the drawings.
D	Fire Extinguisher	Yes	Provide 1 sign at each fire extinguisher
E	Notice: Uniform Dead Load ___ PSF Uniform Live Load ___PSF	No	
G	Notice. Not an exist	No	
H	No Admittance. Staff Only	No	
I	No Smoking in these premises under penalty of fine or imprisonment or both by order of the Fire Commissioner.	No	
J	Exit	Yes	Arrow to point in direction of primary egress.
L	Warning. Eye and ear protection required in this area.	Yes	

M	Warning. Eye protection required in this area.	Yes	
N	Danger. High voltage.	Yes	
O	Stair # Floor Level #. Serves Grade to Floor Level 2	No	Provide 1 sign per level at each stair.
P	Transformer Room ###	No	
Q	Notice. Emergency shut off.	No	
R	Caution. Do not enter authorized personnel only.	No	
S	Notice. Shower and eyewash do not block	Yes	Provide 1 sign at each eyewash / shower station.
T	Energy Storage System. Type of Technology: Lead-Acid Batteries. Special Hazards: Highly Flammable / Explosive. Emergency Number: (###)-###-#### Suppression System: None	No	

B. In addition to the signs included on the drawings, Contractor shall allow for 20 spare general signs of Engineer's choice with regard to size and message.

+ + END OF SECTION + +

SECTION 10522

PORTABLE FIRE PROTECTION EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all portable fire protection equipment Work.
   2. Extent of portable fire protection equipment Work is shown and specified.
   3. Types of portable fire protection equipment Work required includes:
      a. Dry chemical extinguishers.
      b. Carbon dioxide extinguishers.
      c. Mounting accessories and miscellaneous fasteners.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items that must be installed with or before portable fire protection equipment.

C. Related Sections:
   1. Section 10400, Identification Devices.

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. UL Fire Classification Rating.

1.03 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Provide portable fire protection equipment products from one manufacturer.

B. Regulatory Requirements: Provide portable fire extinguishers approved and labeled by UL.

1.04 SUBMITTALS

A. Action Submittals:
   1. Product Data: Submit the following:
      a. Manufacturer’s technical data, certification of UL rating, and installation instructions for portable fire protection equipment.

PART 2 - PRODUCTS

2.01 FIRE EXTINGUISHERS

A. General: Provide manufacturer's standard mounting brackets for portable fire extinguishers size as specified.

B. Multi-Purpose Dry Chemical Fire Extinguishers:
   1. Ten-pound capacity, enameled steel container with pressure-indicating gauge, for Class A, Class B, Class C fires, UL rating 4A-60 BC.
   2. Products and Manufacturers: Provide one of the following:
      a. Cosmic Model 10E by J.L. Industries.
      b. Or approved equal.

C. Carbon Dioxide Fire Extinguishers:
   1. Ten-pound enameled steel container capacity, for Class B and Class C fires UL rating.
   2. Products and Manufacturers: Provide one of the following:
      a. Sentinel Model 10 by J.L. Industries.
      b. Pro 460 Model by Kidde Commercial Division
      c. Or approved equal.

2.02 FIRE-PROTECTION CABINETS

A. Cabinet Type: Suitable for fire extinguishers.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Activar Construction Products Group, Inc. - JL Industries, Inc. (Basis of Design)
      b. Larsen's Manufacturing Company.
      c. Potter Roemer LLC.

B. Cabinet Construction: Exterior Rated

C. Cabinet Series: Decorline - Aluminum.

D. Surface Mounted Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

E. Cabinet Trim Material: Same material and finish as door.

F. Door Material: Aluminum (ASTM B221).
   1. Color and Finish: Silver (SI)

G. Tub Material: Cold rolled steel (standard) with Silver Powder-Coat finish.

H. Door Style: Solid Panel with Small View window with pull handle.

I. Door Glazing: Clear Acrylic.

J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
   1. Provide surface-mounted door pull and friction latch as per manufacturer's standards and as selected or indicated on the drawings.
   2. Provide manufacturer's standard hinge permitting door to open 180 degrees.

K. Accessories:
   1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
   3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as specified.
      a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
         1) Location: Applied to cabinet door.
         2) Application Process: Pressure-sensitive vinyl letters.
         3) Lettering Color: Red.
         4) Orientation: Vertical.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine substrates and conditions under which portable fire protection equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Engineer.

3.02 INSTALLATION OF FIRE EXTINGUISHERS

A. When exact locations of portable fire protection equipment are not shown on Drawings, locate as directed by Engineer.

B. Securely fasten products to structure, square and plumb, per Supplier’s instructions. Mounting heights shall be:
   1. Install fire extinguishers with gross weight greater than 40 pounds with top of fire extinguisher no more than 3.5 feet above finished floor.
   2. Install fire extinguishers with gross weight less than 40 pounds with top of fire extinguisher no more than 4.0 feet above finished floor.
   3. Clearance between bottom of fire extinguisher and finished floor shall be at least four inches.

C. Identification Devices: Provide signs level and plumb directly above surface mounted portable fire extinguishers, securely mounted, attached to substrate per sign manufacturer's instructions. Signage shall be per Section 10400, Identification Devices.

D. Recharge fire extinguishers provided under this Contract so that most recent inspection date coincides as nearly as possible with date of Substantial Completion. Inform Owner in writing of next required inspection and recharging date.

+ + END OF SECTION + +

SECTION 11610

INTEGRALLY GEARED SINGLE STAGE CENTRIFUGAL BLOWERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, test and place into satisfactory operating condition five integrally geared single stage centrifugal blowers complete and operational.
   2. Included are blowers, drives, cooling system, inlet guide vanes, discharge diffusers, inlet filter/silencer, discharge valves, blowoff system, control panels, anchorage systems, anchor bolts and all appurtenances.
   3. Furnish and install a local control panel for 120 Vac and 24 VDC loads for each blower.
   4. Furnish and install one Aeration Control Panel (ACP) per Section 13430 – Process Control Panels and Enclosures
   5. Furnish and install Control Panel PLCs per Section 13451 – PLC Hardware and Software and Section 13451 – Control and Data Equipment
   6. Furnish and install basin valves and aeration instrumentation per Section 15100 – Process and Civil Valves
   7. Furnishing and installation of the process aeration control system hardware and software required for automatic control and monitoring of the entire process air system as specified in Section 13491.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the integrally geared single stage centrifugal blowers Work.

C. Related Sections:
   1. Section 01730 – Operations and Maintenance Data
   2. Section 09900 – Painting
   3. Section 13401 – Process Control System General Provisions
   4. Section 13420 – Primary Sensors and Field Instruments
   5. Section 13430 – Process Control Panels and Enclosures
   6. Section 13451 – PLC Hardware and Software
   7. Section 13451 – Control and Data Equipment
   8. Section 13491 – Process Control Descriptions

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Bearing Manufacturers Association, (ABMA).
   2. American Gear Manufacturers Association, (AGMA).
      a. AGMA 390.03, Handbook - Gear Classification, Materials and Measuring Methods for Bevel, Hypoid, Fine Pitch Worm Gearing and Racks only as Unassembled Gears.
      b. AGMA 6025, Specification for Measurement of Sound for Enclosed Helical, Herring Bone and Spiral Bevel Gear Units.
   3. American National Standards Institute, (ANSI).
      a. ANSI S1.2, Method for Physical Measurement of Sound.
      b. ANSI S5.1, CAGI-PNEUROP Test Code for the Measurement of Sound from Pneumatic Equipment.
   4. American Society of Mechanical Engineers, (ASME).
      a. ASME PTC 13, Test Code on Compressors and Exhausters.
   5. American Society for Testing Materials (ASTM).
      a. ASTM A 36/ A 36M, Specification for Carbon Structural Steel.
      b. ASTM A 48/A 48M, Specification for Grey Iron Castings.
      c. ASTM A 237, Specification for Alloy Steel Forgings for General Industrial Use.
      d. ASTM A 471, Specifications for Vacuum-Treated Alloy Steel Forgings for Turbine Rotor Discs and Wheels.
      e. ASTM A 536, Specification for Ductile Iron Castings.
      f. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
      g. ASTM E 109, Method for Dry Powder Magnetic Particle Inspection.
      h. ASTM E 477, Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
   6. American Welding Society, (AWS).
      a. AWS D1.1/D1.1M, Structural Welding Code-Steel.
   7. International Electrotechnical Commission, (IEC).
   8. Institute of Electrical and Electronics Engineers, (IEEE).
      a. IEEE 85, Airborne Sound Measurements for Rotating Electrical Machinery.
      b. IEEE 112, Test Procedure for Polyphase Induction Motors and Generators.
   9. International Standards Organization, (ISO).
      a. ISO 3945, Mechanical Vibration of Large Rotating Machinery.
   10. National Electrical Code, (NEC).
   11. National Electrical Manufacturers Association, (NEMA).
   12. National Fire Protection Association, (NFPA).
      a. NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   13. Underwriters' Laboratories, Inc., (UL).

a. UL 723, Test for Surface Burning Characteristics of Building Materials.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years of experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single stage centrifugal air blower manufacturer.
   2. The single stage centrifugal air blower equipment manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the single stage centrifugal air blower equipment manufacturer.

C. Coordination Meeting:
   1. A coordination meeting shall be scheduled within 30 days from approval of process air blower shop drawings and held in the ENGINEER'S offices in the Bay Park Sewage Treatment Plant (STP). The purpose of this meeting is to discuss all aspects of blower instrumentation and control. CONTRACTOR and manufacturer's representatives shall be in attendance.

D. Maximum Power Input Requirement:
   1. The average of the wire KW draw of each electric motor driven blower unit at the Design Condition and at seventy percent of the design capacity shall not exceed the maximum specified in paragraph 2.1.C. The motor wire kW of the oil pump, if provided with a separate motor, shall be included. Average as defined as:

$$\frac{\text{Max. wire KW draw @ 100\% + Max. wire KW draw @ 70\%}}{2}$$

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings: Submit the following:
      a. A complete and detailed submittal indicating equipment and controls to be provided, as well as system operation and sequencing, prior to equipment fabrication.
      b. Manufacturer's literature, illustrations, specifications and engineering data.
      c. Drawings showing fabrication methods, assembly, accessories,

installation details and wiring diagrams.

d. Designing, furnishing and installation of anchor bolts including provision of setting drawings, templates, and directions for the installation of anchor bolts and other anchorages. Anchor bolts shall be of 316 stainless steel.

e. Detailed drawings of control panel interior and exterior, including instruments, panel wiring, and Programmable Logic Controllers, (PLC) furnished in accordance with the requirements of the applicable Sections of Division 13.

f. PLC input and output identification and register location.

g. The performance curves of the blowers at the specified operating ranges in Paragraph 2.1.B., including brake horsepower curves from the primary rating point to the maximum turndown point.

B. Informational Submittals: Submit the following:

1. Supporting Data: In addition to Shop Drawings required above, submit the following data and information:

a. Computations showing the manufacturer's maximum power input at the design condition, at 70 percent, and at maximum turndown of the design capacity for each size blower unit.

b. The overall efficiency and power consumption of the blower units shall be taken as the power input to the blower motor, with auxiliary equipment attached and operating, as determined from the shop test. The efficiency data of the motor shall be submitted.

c. A complete list of all equipment to be furnished and the manner in which it will be shipped, e.g. blower, motor and coupling mounted on base plate and shipped as one unit; blower, motor, etc., shipped separately. The list shall be specific to quantities included.

d. Name of the manufacturer of each major piece of equipment proposed, and country in which it will be manufactured.

e. Weight of each blower unit including motor, common base plate, inlet filter/silencer, blowoff system, cooling system and lubrication system. Calculations for all static, torsional and dynamic loads imposed by the blower, motor, gearbox, inlet filter/silencer, and discharge pipeline from the blower to the discharge valve including the blowoff system on the foundation, equipment supports and pipe supports.

f. A statement of the torsional and lateral critical speeds of each blower system mounted on the common baseplate.

g. For each motor furnish a certified motor data sheet. Provide the following minimum data:

1) Starting torque.
2) Efficiency at 1/2, 3/4 and full load.
3) Power Factor at 1/2, 3/4 and full load.
4) Percent slip.
5) No load, full load and locked rotor current.

6) Temperature rises and results of dielectric tests.
7) Bearing type and lubrication medium.
8) Insulation and enclosure type.
9) Motor type and frame size.

h. For each blower motor the following additional data shall be provided:
1) Time versus current curve showing maximum safe stall time and acceleration time versus current at the reduced voltage, based on load Wk2 and starting from normal rated conditions.
2) A curve of speed versus torque, current and power factor from zero to rated speed under starting conditions.
3) All curves shall indicate motor Wk2, specification and tag number.
4) Outline drawing or an outline data sheet showing complete motor dimensions with complete motor data.

i. A description of the proposed shop testing procedures for the blowers, motors and control panels.

j. The following data for the blowers:
1) Wk2 of the blower.
2) Balancing tolerance either in inch-ounces or mils deflection.
3) Description of maintenance procedure to be followed if rebalancing of blower becomes necessary.
4) General description and descriptive calculations of the design reserve capacity of axial thrust bearings.
5) Speed-torque curve for the blower with guide vanes in starting position.
6) A statement of the expected bearing life for each type of bearing provided.

k. Description of the protective coating system proposed for the blowers, motors, base plates and appurtenances.

l. A statement of the expected in situ sound level of the blower and electric motor assembly at five feet from the units, measured in decibels in the A-weighted scale.
1) The statement shall be accompanied by a witnessed sound pressure level test report for each size unit with a common-base-plate-mounted blower and motor, unsilenced, of the identical type and size, or a size ranging from thirty-five percent lesser to thirty-five percent greater than the units specified. The test shall have been performed in accordance with ANSI S1.11 and signed and sealed by a Registered Professional Engineer who may be an employee of the manufacturer.
2) In lieu of the witnessed sound pressure level test report required above, the manufacturer may submit a notarized affidavit guaranteeing to perform any remedial work on the blower and motors that may be required to achieve the sound pressure level, specified in Paragraph 2.16., below.
3) Remedial Work shall be limited to internal areas of the blowers or motors or external applications of sound deadening media such as lead

based sound insulation/acoustical material applied directly to the unit. Remedial Work consisting of sound deadening enclosures or structures erected around the units will not be acceptable.

m. A list of installations in which equipment of this type and approximate capacity has been successfully supplying air for the activated sludge wastewater treatment process, and a statement indicating the length of time that the equipment has been in service.

n. Include the following information in the submittal for the PLC:
   1) Manufacturer's data sheets and catalog literature.
   2) Description of on-line diagnostic tests and off-line tests.
   3) Dimensional data for control panels.
   4) Addressing system and card layout, including special configuration rules and limitations.
   5) Interface and cable data.
   6) Hardware manuals.
   7) Electrical characteristics and protection provided for each component.
   8) Indicate modularity of I/O modules.
   9) Manufacturer's installation instructions for grounding and power conditioning requirements, if any.
   10) Description of how each PLC operates. Include a description of the PLC input/output functions, control capabilities, and configuration procedures.
   11) Description of how faults are detected, isolated and corrected.
   12) Configuration of specific applications(s) with I/O listings, ladder logic, ampacity and impedance coordination.
   13) Ladder logic application programming manual.

o. Include the following information in the submittal for the PLC to Process Supervisory Control and Data Acquisition (SCADA) System gateway capability:
   1) Describe the data transmission protocols, error recovery routines and available utility functions.
   2) Manufacturer's data sheets and catalog literature.

p. Include the following information in the submittal for the development system.
   1) Description of hardware, software and documentation.
   2) Provide two copies of reference documentation for application software development. These are in addition to other documentation requirements and are to be provided at the time of the development system delivery.

q. Listing of manufacturer's recommended spare parts.

r. Three fully annotated printouts of PLC programs including the following:
   1) A memory map with descriptions of each word and file.
   2) A full cross reference report with descriptions for each bit and word

address.

3) A ladder logic diagram with descriptions of each rung of logic. The ladder logic diagram shall also be broken into segments and a Table of Contents provided showing the page number of each segment.

s. Three portable hard drives or flash drives with the full PLC program and documentation. This documentation shall be compatible with the personal computer and software package provided for the development system.

2. Shop Witness Test Results:
   a. Submit results of all specified blower shop witness tests.
   b. Submit results of all specified electric motor shop witness tests.
3. Field Test Results:
   a. Submit a written test procedure and report giving the results of the field tests required.

C. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Manuals:
      a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
      b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01730, Operations and Maintenance Data.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Description:
   1. Blowers shall be designed for continuous 365-days, 24-hours per day, seven days per week operation, shall be suitable for the process and service conditions described below and in the Schedule of Service Conditions.

B. Operating Conditions: Furnish blower units suitable for continuous operation under the following conditions:

Inlet temperature range, degrees F	0 to 95
Barometric pressure range, psia	14.70 to 14.70
Inlet pressure range, psia	14.40 to 14.46
Discharge pressure range, psig	6.3 to 7.9
Relative humidity range, %	5 to 64

C. Rating: Furnish each blower in accordance with the following rating data:

Inlet air temperature, degrees F	95
Inlet air volume – Primary Rating Point , scfm*	30,000
Inlet air volume -Primary Rating Point, acfm**	31,972
Inlet Air Volume- Max Turndown, scfm*	12,000
Inlet air relative humidity, percent	40
Barometric pressure, psia	14.70
Inlet pressure, psia	14.50
Discharge pressure, psig	7.90
Blower maximum speed, rpm	6,100
Maximum noise level (with silencers), decibel level dBA (3 feet from machinery)	90
Average wire power consumption per ASME PTC-13 as defined in Paragraoh 1.3D at rating conditions detailed above, kW	804 k

* SCFM is defined as air at 14.7 psia, 68°F and 36 percent relative humidity.
** ACFM is the actual inlet volume at building intake and at specified

conditions.

The blower capacity shall be corrected for the pressure loss from the building intake to the blower inlet to obtain the air flow rate at the blower inlet.

The following formula shall be used to convert the standard air flow (SCFM) to actual air flow (ACFM):

$$ACFM = SCFM \times \frac{T_1 \times P_b \left[P_s - (RH_s \times PV_s)\right] MW_{air} + \left[RH_s \times PV_s\right] MW_{wat}}{T_s \times P_1 \times \left[P_b - (RH_1 \times PV_1)\right] MW_{air} + \left[RH_1 \times PV_1\right] MW_{wat}}$$

Where P_s = Pressure-Standard Condition, 14.7 psia.

T_s = Temperature-Standard Condition, 528 R.

RH_s = Relative Humidity-Standard Condition, 0.36.

PV_s = Vapor Pressure of Water at T_s, 0.3391.

T_1 = Design Temperature.

P_1 = Pressure at Blower Inlet.

RH_1 = Relative Humidity-Design Condition.

PV_1 = Vapor Pressure of Water at T_1.

P_b = Barometric Pressure.

MW_{air} = Molecular Weight of Air, 28.97.

MW_{wat} = Molecular Weight of Water, 18.02.

D. Specific Requirements:
   1. Each electric motor driven blower shall not require more than 1250 horsepower at the Design Condition.
   2. Each electric motor driven blower shall not have a noise level greater than 90 dBA, emanating from the blower and motor at a distance of five feet from the blower and motor.
   3. Blowers shall develop a pressure rise to surge of at least 1.0 psig at rating conditions defined above. Unit designed with lower rise to surge will not be acceptable.
   4. Each electric motor driven blower shall be capable of accelerating from zero to operating speed within twenty seconds.

2.2 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:
   1. Lonestar, Model GL20
   2. Howden, Model KA66SV-GL400
   3. NEXT Turbo, Model GTH-T60-XY

2.3 DETAILS OF CONSTRUCTION - BLOWER

A. Base:
   1. Mount each blower and its electric drive motor on a common, welded structural ASTM A 36/A 36M steel base. Fabricate the base of structural members or heavy steel plate and strongly reinforce to make it rigid.
   2. Welding shall conform to the AWS or equal National Code. Provide a sufficient number of leveling screws and subsole plates located around each anchor bolt for ease of alignment of the blower/motor assembly.

B. Casing:
   1. Casing shall be of close grained gray cast-iron, conforming to ASTM A 48/A 48M, Class 30, or modular iron conforming to ASTM A 536, Grade 60-40-18. Both inlet and discharge connections shall be cast integrally with the casing and shall be machined and drilled accurately to ANSI Standards. Provide the casings with starting screws and eye-bolts or lugs for lifting.

C. Shaft:
   1. Shaft shall be of high-grade steel single forgings, conforming to ASTM A 471 or ASTM A 237, annealed, or equal, finished all over and accurately ground to gauge where necessary.
   2. Shaft shall be of the stiff or flexible shaft design with the first critical speed at least 20 percent removed from the operating speed. Renewable shaft sleeves shall be provided at close clearance points, and at all points subject to abrasion, erosion and corrosion. Shaft seals shall be accessible for inspection and ready replacement.
   3. Shafts shall be high quality heat-treated alloy steel of sufficient diameter and strength for the service intended. Rotating elements shall be dynamically balanced.

D. Impeller:
   1. Impeller shall be radial or backward leaning type of aluminum alloy or machined from alloy steel, conforming to ASTM A 471, or equal, heat treated, or of 17-4 PH stainless steel, secured to the shaft in an approved manner to withstand all working stresses, and in particular, stresses incident to the starting of the blower.
   2. Impeller shall be statically and dynamically balanced and tested for operation

at operating speeds.

3. Perform a lateral critical speed and composite torsion analysis of blower and driver. There shall be no torsional critical speeds within the operating range of the unit.

E. Bearings:

1. Provide each blower with pressure oil lubricated bearings designed for a minimum service life of ten years. High speed bearings shall be of the tilting pad type. Low speed pinion bearings shall be precision sleeve type. High speed thrust bearings shall be double acting. Anti-friction bearings are not acceptable. Bearings shall be of bronze or the split sleeve steel backed, babbitted type with adequate provision for lubrication and shall be replaceable without removing the rotors.

F. Lubrication:

1. Provide a factory assembled pressure lube oil system with each blower unit. Each system shall consist of two pumps, oil reservoir, two filters, strainers, appurtenances and an oil cooler. The oil cooler shall supply clean oil at suitable pressure to lubricate the blower bearings and speed increasing gears and bearings. All components shall be installed on, or integral with, the blower baseplate and be arranged to permit ease of accessibility for operation, maintenance, inspection and cleaning.
2. Valved vent connections and any necessary piping shall be designed to facilitate cleaning, filling and draining of idle equipment during blower operation. Adequate unions shall be provided to allow easy disassembly of all piping. Piping shall be hydraulic tubing.
3. Pumps: The main lubrication oil pumps shall be of the positive displacement type, positively driven from the drive train and of adequate capacity to supply the lubricating requirements of the blower and speed increasing gears. An electric motor driven auxiliary oil pump shall be provided to obtain an adequate oil pressure at the bearings immediately prior to blower startup, until the main oil pump has built up sufficient pressure, and during shutdown. The auxiliary oil pump shall have the same capacity as the blower driven oil pump. Motor shall be suitable for operation on 480 volt, 3 phase, 60 Hz power.
4. Oil Reservoir: Size oil reservoir to hold a minimum of five times the gallon per minute requirements of the blower and motor; with necessary devices for checking oil level, and with drain and cleaning openings. Furnish lube oil electric immersion heater for 480 volt, 3 phase, 60 Hz operation, complete with control thermostat, and magnetic contactor. Interior of oil reservoir shall be descaled and rustproofed by the manufacturer's standard permanent coating. Reservoirs with top mounted equipment shall have sufficient rigidity to prevent sagging and vibration. Any equipment attached to the top of the reservoir shall be mounted by means of pads to ensure that no tapped holes will extend into the reservoir. Seal each reservoir against the entrance of dirt, water or other contaminants. All cover openings shall be gasketed. Both

intake and return shall be brought below minimum working fluid level. Reservoir shall be baffled to minimize air entrainment and isolate foam. Provide the fill opening with a strainer. Supply a sight gage oil level indicator and low level switch for each reservoir and equip each reservoir with a suitably sized vent and breather filter.

5. Oil Filters: Provide two parallel full flow oil filters of the replaceable cartridge type, each capable of removing particles over ten microns with a clean oil filter pressure drop not to exceed five psi at design temperature and flow. Filter cases and heads shall be of steel and shall be suitable for operation at a pressure not less than the relief valve setting of the positive displacement oil pumps. Filter cartridge materials shall be corrosion resistant to water in the oil. Oil filters shall be replaceable (one at a time) while operating.
6. Strainers: Strainers shall be manually cleaned type and equipped with magnetic trap. Design and installation shall permit ready access for cleaning.
7. Provide a 2 inch 316 stainless steel solenoid valve for control of cooling water flow to each cooler.
8. Oil Cooler:
    a. Water to Oil Cooler: Provide a 316 stainless steel water to oil cooler mounted integral to the blower and factory piped to maintain constant oil temperature, mounted on each blower skid as well as a bypass pipe around the cooler. Both the hot and cold pipes shall combine into a temperature control mixing valve for regulating constant oil temperature to the blower gearbox. Piping, tubing and valves shall be of 316 stainless steel.
        1) Manufacturers: Provide water to oil coolers of one of the following:
            a) Basco
            b) Southwest Thermal Technology
            c) Or equal.

G. Seals:
1. Provide a labyrinth seal where the rotor shaft passes through the casing to limit air leakage along the shaft. Provide a combination of oil slingers and labyrinth seals to prevent oil leakage from the gearbox. All seals shall be replaceable.

H. Speed Increasing Gears:
1. Speed increasing gears, shall be of the single or double helical, parallel shaft type. All gears shall be manufactured in accordance with the American Gear Manufacturers Association requirements including the requirements of AGMA 6025.
2. Gears shall be of ample size and rating to transmit the maximum torque and horsepower input requirements to the blower under all operating conditions with a minimum efficiency of 96.0 percent. The service factor for rating the gears shall be a minimum of 1.5 applied to the full load horsepower of the blower motor nameplate rating. Gears shall be rated for continuous duty with ambient temperatures ranging from 40°F to 110°F. Coat all exposed machined

surfaces with a corrosion resisting compound for shipment.

3. Housing: The gear drive housing shall be integral with the blower, of high grade cast-iron, and sufficiently rigid to maintain the shaft positions under maximum loads. Gear housing assemblies shall be accurately machined to close tolerances for bearing fits, gear alignment and oil tightness. The housing shall be split to facilitate inspection of the internals.
4. Gearing: Gears shall be made of alloy steel forgings with the gear teeth precision hobbed and shaved. Gears shall be manufactured to a minimum AGMA quality number of not less than twelve as specified in AGMA 390.03.
5. The gearbox shall be provided with bearing temperature sensors

I. Blower Air Vanes: Provide each blower with both the inlet and diffuser stainless steel vane assemblies .

1. Adjustable Air Diffuser Vane Assembly:
    a. Mount adjustable air diffuser vane assembly integral with each process air blower. Vanes shall be multileaf and pivoted. Variable discharge diffuser blades shall be mounted in a cast-iron housing. Sleeve bearings shall be of the permanently lubricated type and the linkage shall be readily accessible for lubrication. Vanes shall be mechanically stopped for a maximum closed setting of 75 degrees (15 degree open). Adjustable diffuser assembly shall be installed complete with a motorized actuator to operate from a 4 to 20 mADC modulating signal. Mount an adjustable limit switch on each adjustable diffuser actuator to energize a light on the blower control panel when the vanes are at the maximum closing setting. Provide an indicating manual/auto station with remote setpoint capability at the blower control panel. Provide an emergency manual operator for the vanes. The motor actuator shall operate on 480 volt, 3 phase, 60 Hz. Actuator shall be provided with a unit mounted disconnect.
2. Inlet Air Guide Vane Assembly:
    a. Mount inlet guide vane assembly integral with each air blower. Vanes shall be multileaf and pivoted to produce optimum pre-rotation of the incoming air stream. Bearings shall be of the permanently lubricated type and the linkage shall be readily accessible for lubrication. Vanes shall be mechanically stopped for a maximum closed setting of 75 degrees (15 degrees open). Guide vane assembly shall be installed complete with a motorized actuator to operate from a 4 to 20 mADC modulating signal. Mount an adjustable limit switch on each guide vane actuator to energize a light on the blower control panel when the vanes are at the maximum close setting. Provide a 4 to 20 mADC signal for remote indication of guide vane position. Provide an emergency manual operator for the vanes. Motor actuator shall operate on 480 volt, 3 phase, 60 Hz. Actuator shall be equipped with unit mounted disconnect.

2.4 DETAILS OF CONSTRUCTION - DRIVE

A. Electric Motor Driver:

1. Motor rating and characteristics and all materials and construction shall be in accordance with the latest standards of ANSI, IEEE, ABMA and NEMA as applicable.
2. Motor shall be a WPII motor with Class F insulation, high efficiency type design, with a maximum speed of 3,600 rpm.
3. Motor shall be suitable for operation on 4,160 volt, 3 phase, 60 Hz power.
4. Motor shall have sufficient torque and thermal capacity to successfully start and accelerate the coupled blower from the plant power system without subjecting the motor to excessive heating. The stator windings and end turn connections shall be fully brazed to withstand full voltage starting regardless of whether reduced voltage startup is utilized. The motor shall be not less than the horsepower required in the Schedule of Service Conditions. Motor shall have a 1.15 service factor.
5. Locked rotor current shall be as specified in NEMA standards.
6. Motor enclosure shall be for top air inlet and discharge. Apply acoustical treatment as required to comply with noise limitations specified herein.
7. Motor frames and end shields shall be heavy fabricated steel or cast-iron of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed.
8. Provide space heaters, 120 volt, single phase.
9. Shaft shall be made of high-grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating.
10. Stator cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations. Stator coils shall be form wound and of identical size, shape, insulation and number of turns.
11. Stators shall be form wound and insulated with glass and mica applied directly to the coils. Motors shall have a Class F non-hygroscopic epoxy vacuum/pressure impregnated insulation system, limited to the temperature rise specified herein. All connections shall be brazed, with no crimp connections used except for terminals. A coil bracing for stator end turns shall be utilized to eliminate coil movement and vibration during starting and running conditions. Stator design and construction shall be such as to secure mechanical rigidity to withstand repeated full voltage starts and eliminate over-heating.
12. Rotors shall be made from high-grade steel laminations adequately fastened together, and to the shaft. Rotor squirrel cage windings may be cast or extruded copper alloy bar-type construction with brazed end rings.
13. Bearings shall be anti-friction type, oil lubricated. Bearings shall be designed to prevent leakage of oil and entrance of dust, shall contain a large oil sump with settling chamber, and shall be equipped with a guarded sight gauge, plugged drain cock, and filler connection. Bearings shall have a minimum B-

10 life of 100,000 hours.

14. Motors shall have a chemical resistant, corrosion and fungus protective coating on all interior surfaces. Exterior prime coating shall be compatible with the finish coating.
15. Enclosures shall have stainless steel screen and shall be protected against corrosion, fungus and insects.
16. All fittings, bolts, nuts and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads.
17. Motor shall have a stainless steel nameplate which shall provide the following: type, frame, insulation, class, HP, full load current, RPM, centigrade degree rise, manufacturer's name and serial number, model number, voltage, locked rotor KVA code, bearing numbers and a connection diagram. Main terminal box shall be NEMA 12. Manufacturer shall furnish lightning arrestors and surge arrestors mounted in the terminal box.
18. Main terminal box shall have provisions for mounting differential protection current transformers and for proper termination of shielded cables. Sufficient space shall be provided for 5 KV shielded, EPR insulated, PVC jacketed cable terminations. Leads from each phase winding shall be securely clamped near the point where they exit the stator frame and shall be clearly identified.
19. Motors shall have the following minimum efficiencies:
    a. Minimum full load efficiency of 95.7% percent when operating at rated voltage and frequency. The motors shall have a 3/4 load efficiency of 95.5% percent and 1/2 load efficiency of 94.8% percent when operating at rated voltage and frequency.
20. Motors shall be free of objectionable noise and vibration. Motor sound pressure level shall not exceed 90 dBA at four feet under free field, no load conditions in accordance with IEEE 85. Vibration level measured on the bearing housing shall be in accordance with values shown in NEMA Standards.
21. Motors shall be rated for continuous operation in an ambient temperature not exceeding 40°C. The temperature rise as measured by the resistance method shall not be more than 80°C, or 85°C by embedded detector at design horsepower nor more than 90°C by embedded detector at 1.15 service factor.
22. Six platinum resistance temperature detectors (RTDs) as specified in Section 13420, Primary Sensors and Field Instruments, shall be distributed about the stator with two per winding, each being embedded between upper and lower coil in the coil slot. Leads shall be brought out to a separate terminal box through a flexible sleeve which will protect the leads and assure their flexibility after dipping and baking of stator.
23. One dual type resistance temperature detector of the same rating and material as defined above and two vibration sensors shall be provided for each motor bearing and wired to a separate terminal box.
24. Motor shall take in cooling air from the Blower Room air and shall discharge cooling air back into the Blower Room. Cooling air discharge shall be upward from the motor enclosure. Suitable fan blades shall be installed at both ends of

rotor to force air axially along the rotor with minimum windage noise. Ventilation openings shall be provided with suitable grilles or baffles, and screens.

25. Manufacturers: Provide equipment of one of the following:
    a. ABB
    b. Nidec
    c. WEG

2.5 BLOWER-DRIVER COUPLINGS

A. Flexible couplings, selected on the basis of a system torsional analysis, shall be of the gear or flexible disk type designed to permit axial, horizontal and vertical adjustments, and shall provide for changes of angular and parallel misalignment between the blower and motor.

B. Couplings shall be designed to hold the end play of the motor rotor within acceptable limits and shall be designed with a service factor of 1.50.

C. Provide an approved 316 stainless steel coupling guard of minimum 14-gauge and install over the coupling.

2.6 MOUNTING AND VIBRATION LIMITATION

A. Each blower and electric motor, coupled together, shall be factory-mounted on a common steel base, properly braced to form a rigid support for the entire assembly. The units shall be factory aligned on the base prior to shipment. The common base shall be designed and constructed such that it will fit upon a concrete support pad while properly supporting the blower and motor thereon. Suitable anti-vibration pads, bolts, or pins shall be furnished by the manufacturer for use when mounting the common base on the concrete support pad.

B. Blower, electric motor, base, and shafting shall be designed and installed to limit field vibration to the "satisfactory" maximums recommended by the International Organization of Standardization ISO 3945 (latest revision), "Mechanical Vibration of Large Rotating Machines". In no case shall the field vibration velocity measured at any bearing exceed 0.18-inches per second (rms) for motor driven blowers. These limits shall be met when operating at any point within the specified range of operation at any operating speed.

2.7 ACCESSORIES

A. Flexible Connectors:

1. Provide suitable reinforced flexible connectors for both inlet and outlet piping rated for minimum 25 psi pressure and 300°F air temperature. Flanges shall be

ANSI 125 pound. Harness each joint with four tie rods connected to stainless steel plates fastened to flanges to allow elongation of the joint.

B. Inlet Filter/Silencers:
   1. Each blower shall be provided with an inlet filter/silencer designed for maximum air flow with minimal pressure drop and connected directly to the inlet of the blower via a flexible connector. The coarse pre-filter shall be MERV 8 minimum. The final filter element shall be MERV 11 minimum. The filters shall be sized for a maximum face velocity of 575 FT/minute at peak air flow.
   2. Walls of the silencer shall consist of a sandwiched steel outer skin and an acoustical sound deadening material of one inch. The sound insulation shall contain an inert barrier on the inside of the housing. Legs shall be adjustable for vertical positioning and leveling.
   3. The integral inlet silencer shall consist of a set of baffles, mounted internally in the filter/silencer between the filter elements and the blower inlet.
   4. The filter elements shall be panel and removable through steel doors located on each side of the steel housing.
   5. The CONTRACTOR shall connect the filter/silencer to the blower inlet via a flexible connector provided by the MANUFACTURER.
   6. The CONTRACTOR shall provide louvers and transition pieces between louvers and inlet filter/silencers

C. Blower Blowoff Valve, Blower Discharge Isolation Valve, Process Air Lateral Flow Control Valves, and Main Header Blow-off Valve:
   1. Furnish and install one motor operated butterfly valve for blow-off and discharge isolation valve for each blower (PDV1 to PDV5 and PBV1 to PBV5). Furnish and install ten motor operated butterfly valves for process air flow control to each process air lateral (TCV 1A and 1C to TCV 5A and 5C) and one main header blowoff valve. The blower manufacturer shall be responsible for final selection and sizing of the valves as required to function properly with his process air control system. Butterfly valves shall be installed complete with an actuators to operate from full open to full closed position over a minimum time period of 20 seconds. Operators shall be equipped with two adjustable limit switches to energize lights on the blower control panel when the valve is full open or full closed. Motor shall operate on 480 volts, 3 phase, 60 Hz. Operators shall be sized for operation at the rated pressure of the valve. The units shall include motor complete with pre-wired starter, operator unit, gearing, torque switches, bored and key-wayed drive sleeve, declutch lever, auxiliary handwheel as a self-contained unit and limit switches as specified herein. Motor shall have a service factor of 1.15. Power gearing shall consist of generated helical gears of heat treated steel and worm gearing. Worm shall be of hardened alloy steel. Power gearing shall be grease lubricated. Ball or roller bearings shall be used throughout. Provide "OPEN" and "CLOSE" pushbuttons and a "MANUAL/ AUTOMATIC" selector switch at the blower control panel. Provide a NEMA 4X remote hand station suitable for remote

connection to each actuator. Remote hand station shall incorporate local controls for Open, Close and Stop and a Local/Stop/Remote mode selector switch lockable in any one of the following three positions: local control only, stop (no electrical operation), remote control plus local stop only. It shall be possible to select maintained or non-maintained local control.

2. The butterfly valves shall be high performance butterfly valves as specified below:
   a. Manufacturers: Provide products of one of the following:
      1) DeZurik
      2) Keystone
      3) Pratt
   b. For butterfly valves 6 inches and larger, provide valve materials as specified below or as required for the service:
      1) Valve bodies: Type 316 stainless steel, ASTM A351, Grade CF8M
      2) Valve shafts: 17-4 PH stainless steel, ASTM A564, Type 630, H1150M ,
      3) Valve discs: Type 316 stainless steel, ASTM A351, Grade CF8M
      4) Seat Retainer: Type 316 stainless steel, ASTM A240
      5) Seat Ring: Polytetrafluoroethylene
      6) Back-up Ring: Titanium ASTM B265, Grade 3
      7) Locator Bearing Carrier: Type 317 stainless steel, ASTM A743, Grade CG8M
      8) Liner: Type 317 stainless steel with polytretrafluoroethylene (PTFE) woven fabric
      9) Thrust Bearing: Type 317 stainless steel with PTFE woven fabric
      10) Packing: Polytetrafluoroethylene (PTFE)
      11) Packing Gland: Type 317 stainless steel, ASTM A743, Grade CF8M
      12) Disc Pins: Type 316 or 317 stainless steel, ASTM A276

   c. All internal and external bolting and other hardware including pins, set screws, studs, bolts, nuts and washers: Type 316 stainless steel.
   d. General:
      1) Rated Working Pressure: 150 psi
      2) Internal Temperature Rating: 300 degrees F, minimum
      3) Cv Values
   e. The valves shall be suitable for modulating service and provide a control range between 20 to 80 percent open, as a minimum.
   f. Body Style: Lugged, ANSI Class 150.
   g. Disc: Airfoil design.
   h. The valves shall provide bidirectional shut-off at the rated pressures. The valves shall be capable of being held in open or partially open position for manual operation or for automatic operation. When the disc is so held, there shall be no chatter or vibration of the disc or operating mechanism.

D. Air Flow Venturi Meters: Furnish and install ten process air flow venturi meters as specified in section 13420. The blower manufacturer shall be responsible for final selection and sizing of the venturi meters as required to function properly with his process air control system.

E. Blow-off Silencer
   1. A carbon steel blow-off silencer shall be provided for each blower and main header blow-off valve. Internal baffles, packed with sound absorbent material, shall direct air flow around three (3) 90 ° turns in an annular flow configuration. The blow off silencer shall be an integral unit, fitted with one (1) flange for direct bolting to the blow off valve, with installation by the CONTRACTOR.

F. Discharge Check Valve (PCV1 to PCV5)
   1. Provide each blower with a 316 stainless steel wafer type discharge check valve of the dual plate type with center hinge, spring closure, cast iron body, EPDM seal and aluminum plates, stainless steel springs, and rated for temperatures up to 300 Deg F. The check valve shall be mounted and installed by the CONTRACTOR in a horizontal/vertical (Except vertical downward) run of piping, as shown on the drawings. Check valve shall be manufactured by US Valve or approved equal manufacturer.

G. Protective Devices:
   1. Provide a temperature indicator on the blower discharge piping from each blower. Temperature sensors shall be included with gearbox as indicated on the P&ID. Gearbox high temperature shall indicate impending high temperature level and shall actuate an alarm and high-high temperature shall shut down the blower and actuate an alarm.
   2. Furnish a pressure transmitter for installation in the blower discharge piping from each blower Upon a high discharge pressure condition, blowers shall shut down and actuate an alarm.
   3. Furnish -radial-plane vibration sensors 90 degrees apart at pinion shaft and one axial sensor for the pinion shaft for each blower. Furnish an accelerometer on the motor bearing housings of each blower. High vibration at any sensor shall actuate an alarm and high-high vibration shall shut down the blower.
   4. The required field instruments for monitoring and alarm functions shall be supplied by the manufacturer in accordance with the requirements of Division 13.

H. Discharge Cone:
   1. Each blower outlet shall be supplied with a discharge cone to increase the blower outlet size to the large diameter air discharge piping. The length of the discharge cone shall be aerodynamically designed to minimize pressure drop and discharge turbulence; maximum sidewall angle increase shall be five degrees per side (ten degrees, total). The discharge cone shall have a discharge

flange and bypass flange size as shown. Instrument connections shall be provided as required. The discharge cone shall be constructed of Type 316 stainless steel.

2.8 BLOWER TERMINATION BOXES

A. Provide a blower 480 VAC power termination box, one for each blower suitable for mounting on the blower skid. Terminal blocks shall be provided to centrally terminate all skid mounted devices requiring 480 VAC supply. Box shall be NEMA 12.

B. Provide a blower control termination box, one for each blower suitable for mounting on the blower skid. Terminal block shall be provided to centrally terminate all blower system skid devices. Box shall be NEMA 12 and of sufficient size for all required signals plus 20 percent spare terminals.

C. Power and control boxes shall be completely accessible. All boxes shall conform to the applicable Sections of Division 16, Electrical.

D. Conduit and Wire:

1. Provide all conduit and wire for blower skid devices to the blower termination boxes. Conduit and wire shall conform to the applicable Sections of Division 16, Electrical.

2.9 BLOWER CONTROLS

A. Process and Instrumentation Diagrams:

1. Process and Instrumentation Diagrams are included in the Contract Documents for purposes of guidance and to show functional features only. The diagrams do not necessarily contain or show all components required to accomplish the desired results or all components required to interface equipment. All necessary parts, equipment, wiring and devices necessary to meet the functional and interfacing requirements shall be provided.

B. Instrumentation:

1. Instrumentation components shall be provided by the MANUFACTURER. These components shall be factory installed on the blower skid, except as noted. All factory mounted instrumentation shall be pre-wired to a skid mounted remote I/O panel. All field mounted instruments shall be field wired to the skid mounted remote I/O panel or local control panel by the CONTRACTOR, using the MANUFACTURER's supplied wiring diagrams.

2. Instrumentation for each blower shall include, as a minimum

a. 1st Stage and 2nd stage inlet air filter differential pressure switches. Field mounted and wired by the CONTRACTOR.

1) Refer to Section 13420 – Primary Sensors and Field Instruments.

b. Inlet air temperature sensor.
   1) Pre-installed and wired by factory.
   2) PT100 RTD, Class B.
   3) Shall be Endress Hauser TH11, or approved equal.

c. Inlet air pressure indicating transmitter.
   1) Pre-installed and wired by factory
   2) Transmitter output shall be 4-20mA.
   3) The transmitter shall have a display for the measured process value.
   4) Shall be Endress Hauser PTP31B, or approved equal.

d. Inlet mounted blower surge switch.
   1) Refer to Section 13420 – Primary Sensors and Field Instruments.

e. Discharge pressure indicating transmitter.
   1) Field mounted and wired by the CONTRACTOR.
   2) Transmitter output shall be 4-20mA.
   3) The transmitter shall have a display for the measured process value.
   4) Shall be Endress Hauser PTP31B, or approved equal.

f. Discharge temperature sensor.
   1) Field mounted and wired by the CONTRACTOR.
   2) PT100 RTD, Class B.
   3) Shall be Endress+Hauser TH11, or approved equal.

g. Gearbox inlet oil temperature indicating transmitter.
   1) Pre-installed and wired by factory.
   2) Transmitter output shall be 4-20mA.
   3) The transmitter shall have a display for the measured process value.
   4) Shall be Endress Hauser TTR31, or approved equal.

h. Gearbox Inlet oil pressure indicating transmitter.
   1) Pre-installed and wired by factory.
   2) Transmitter output shall be 4-20mA.
   3) The transmitter shall have a display for the measured process value.
   4) Shall be Endress Hauser PTP31B, or approved equal.

i. Oil filter differential pressure switch.
   1) Refer to Section 13420 – Primary Sensors and Field Instruments.

j. Oil reservoir temperature sensor.
   1) Pre-installed and wired by factory.
   2) PT100 RTD, Class B.
   3) Shall be Endress Hauser TH11, or approved equal.

k. Oil level gauge and low oil level switches.
   1) Pre-installed by factory.
   2) Vented oil gauge with metal/glass construction.
   3) Shall be marked to provide clear indication of appropriate oil levels.

l. Zero speed switch.
   1) Pre-installed and wired by factory.

2) 24VDC, 3-wire, normally closed contact.
3) Switching frequency of 1000 Hz minimum.
4) Shall be Turck BI5U, or approved equal.

m. Motor bearing temperature sensors.
1) Pre-wired by factory.
2) PT100 RTD, Class B.
3) Drive end and non-drive end.

n. Motor winding temperature sensors.
1) Pre-wired by factory.
2) PT100 RTD, Class B.
3) Two per phase, one duty / one spare.

o. Motor bearing vibration, drive end and non-drive end.
1) Pre-installed and wired by factory.
2) Transmitter output shall be 4-20mA.

p. Gearbox bearing temperature sensors, each radial and thrust bearing.
1) Pre-wired by factory.
2) PT100 RTD, Class B.
3) Two per bearing, one duty / one spare.

q. Gearbox pinion shaft vibration.
1) Pre-installed and wired by factory.
2) Transmitter output shall be 4-20mA.
3) Shall be Shinkawa WK/WKN Series, or approved equal.

2.10 SKID-MOUNTED REMOTE I/O PANEL (RIO PANEL)

A. Each blower shall be provided with skid-mounted remote I/O panel for termination of all instrumentation wiring. Additionally, the RIO panel shall provide control and power for skid mounted auxiliary devices and shall include power supplies and transformers for deriving control power. Each assembled RIO panel shall carry a UL label certifying the assembled industrial control panel complies with UL 508A.

B. The RIO panel shall be a NEMA Type 12 enclosure with two independently operable doors, and each side of the enclosure separated by a physical barrier in between. One side shall only contain 24VDC circuits (low voltage side) and the door be capable of being opened without removing power from the system for the purposes of troubleshooting. The other side shall contain the 480VAC and 120VAC components (high voltage side) and shall include a disconnect to prevent opening of that door while the enclosure is energized.

C. The RIO panel shall be fed from a single 480V/3/60, 30amp source that is field wired by the installing CONTRACTOR to the fused disconnect contained within. A 480V SPD (surge protection device) shall also be included. The RIO panel shall include a transformer for deriving its own 120VAC power and a 24VDC power supply.

D. The RIO panel shall include two grounding systems. One ground busbar for equipment ground and one isolated instrument ground busbar. The installing CONTRACTOR shall connect each grounding busbar to the appropriate site grounding system.

E. An Emergency Stop (E-Stop) mushroom style pushbutton shall be mounted on the low voltage door of the remote I/O panel enclosure. A normally closed contact of the E-Stop shall be in series with an E-Stop contact in the local control panel so that the circuit is broken if either E-Stop button is pressed. A relay shall be used to provide a dry contact indicating the E-Stop status. This contact shall be either wired directly to the soft starter or put in series with the run signal to the soft starter as per the project drawings.

F. All instrumentation shall be connected via individually fused circuits to a remote I/O system mounted within the RIO panel. The remote I/O system shall have an Ethernet bus for communicating the values of each instrument to the PLC located in the local control panel. The remote I/O system shall be the Modicon M580 series as manufactured by Schneider Electric. Any additional devices needed to connect instruments to the remote I/O system (such as vibration transmitters) shall also be installed in the RIO panel.

G. Hardwired interconnections to the local control panel shall be limited to an Ethernet cable for connection to the PLC and two conductors for the E-Stop Circuit. Additionally, three conductors (L,N,G) may be used if the local control panel is sourcing its 120VAC power from the RIO panel. Reference the project drawings for the source of the 120VAC to the local control panel.

H. Skid mounted electrical components shall terminate into this enclosure and sufficient terminal blocks shall be provided for field wiring terminations by the CONTRACTOR.

2.11 LOCAL CONTROL PANEL (LCP)

A. Each blower shall be furnished with a PLC-based local control panel (LCP). All controls and instruments shall fail into a safe condition. The controls shall be designed such that the blower cannot operate unless the controls are energized, nor can they operate with any defective controls.

B. The enclosure shall be NEMA Type 12 rated and able to be remote mounted or skid-mounted as shown in the project drawings. Each assembled LCP shall carry a UL label certifying the assembled industrial control panel complies with UL 508A.

C. The control panel shall be powered by a 120VAC source as shown in the project drawings and shall include power supplies within to derive 24VDC control power. A 120VAC SPD (surge protection device) shall be provided for the 120VAC incoming power feed if power is not sourced from the RIO panel.

D. Each blower LCP shall contain controls for blower motor starting, surge and overload detection, shutdown control, alarm and emergency shutdown systems, inlet guide vanes, variable diffuser vanes, discharge valve, blow-off valve, and the oil lubrication system operation.

E. Three phase motor starters and circuit protectors shall be mounted in the high voltage side of the enclosure for providing power to the skid mounted auxiliary motors and heaters. The contactors shall be controlled from the remote I/O mounted in the low voltage side of the enclosure via interposing relays. Circuit protectors shall also be provided for supplying 480VAC power to the discharge valve actuator and blow-off valve actuator.

F. Each LCP shall contain terminal blocks for signals to interface with the main motor starter (Run Command, Run Feedback, Fault Feedback). The starter for the main drive motor shall be installed by the CONTRACTOR as shown in the project drawings.

G. Use destination tagging to identify each end of each wire printed on a wire sleeve marker. Destination tagging identifies the landing point of the other end of the wire.

H. The PLC shall be a Modicon M580 series as manufactured by Schneider Electric, or approved equal. At a minimum, the PLC shall meet the following requirements.
1. Ambient temperature operation up to 60°C
2. Dual Core 1.3GHz Processor or faster
3. 2,048 Mbyte DDR3 SDRAM
4. 12 Mbyte Program Memory
5. 32 Mbyte Mass Storage
6. Realtime Clock
7. X3 RJ45 Ethernet ports capable of 10/100/1000 Mbps (full duplex)
8. Developed according to security standard IEC 62443
9. Integrated and configurable firewall

I. The HMI shall be a model BWP 2102W as manufactured by Phoenix Contact, or approved equal. At a minimum the HMI shall meet the following requirements:
1. 10” or larger color touchscreen.
2. HTML5 capable
3. 1024 x 600 pixel resolution
4. Minimum 65° viewing angle from the sides
5. X1 RJ45 Ethernet port capable of 10/100 Mbps
6. X1 USB Host 2.0 interface

J. The HMI programming shall be part of the PLC program and accessible from the controller via HTML5. This functionality is to allow temporary HMI functionality from a device with a web browser in the event of an HMI failure or easy integration of HMI functionality to additional workstations in the facility.

K. A copy of the PLC and HMI programming software shall be provided to the owner.

L. The operating screens (pages) shall provide not only start-stop and operational mode interfaces, but also alarm status and diagnostics. The following features shall be provided as part of the operator interface screens:

1. Status Bar (all screens) – The top of every screen shall provide a status bar giving status information for primary functions such as running state, alarms, login, local/remote, and operation mode. Additionally, it should be indicated on the status bar if there are any bypass or override values enabled (see Settings Screens).
2. Run/Output Control Screens – The run control screens shall provide the interface for starting/stopping the blower and changing its output. Additionally, under the proper operation modes and login levels, these screens should allow for the starting/stopping of auxiliary devices.
3. Monitoring Screens – The monitoring screens should allow for viewing the blower data and status in different formats at the preference of the operator. The displayed values shall update according to the engineering units selected. At least two visual modes shall be available:
    a. List view with live values and status indicators in a table format. This view shall occupy one screen.
    b. Graphical view showing the live values for each parameter relative to location on the blower equipment.
4. Alarm Screen – The alarm screen shall show any recent alarm conditions from the equipment. Each alarm event shall generate a 'first out' alarm indicating the initial cause of the event to aid in troubleshooting in case other alarm conditions occur during the same event.
5. Settings Screens – Settings shall be viewable under all login levels, but shall only allow changes to setpoints and configuration under a technician or administrative level login. Any settings related to the operation of the equipment shall be available via the HMI. This includes, but is not limited to, scaling values, alarm and trip setpoints, timer settings, and other configuration related items. Additionally, each instrument shall have options for an override value or to bypass trips related to the instrument. A bypass or override may only be enabled under a technician or administrative level login and is intended only for temporary use, but would provide capability for the blower to be operated in the event of a failed sensor until a replacement can be installed.

M. Panel mounted selector switches, pushbuttons, and indicators shall include:

1. Emergency stop mushroom button
2. Remote / Local Selector Switch
3. Indicating lights for guide vanes, discharge diffuser, discharge isolation valve, and bypass valve.
4. Running indicator / pilot light
5. Alarm indicator / pilot light

6. Alarm horn
7. Alarm strobe light

N. Surge events shall be avoided using active measures performed by the control system; however, a secondary surge detection system shall sense unbalanced/surge conditions by use of onboard instrumentation. Detection of surge conditions shall trip the blower off-line.

O. Motor overload protection logic shall be provided to control the maximum vane setting on the blower, so that motor current does not exceed a pre-set overload level.

P. A zero-speed sensor shall be mounted on the gear box to detect rotation when it is not expected. This is typically caused by reverse air flow through the blower caused by a failed isolation valve, check valve, or both. The auxiliary oil pump shall turn on to protect the bearings and the controls shall enter a tripped state.

Q. Guide vane actuator position shall be able to be automatically calibrated by use of a button on the local HMI. This function shall only be accessible while the unit is not running and with a tech level, or higher level, login.

R. Data communication shall be provided between the PLC's, located in each LCP, ACP, and the plant systems via the ethernet protocol. Configuring the interface to the plant system shall be the responsibility of the systems integrator; however, the MANUFACTURER shall actively participate by providing proper interface documentation and support as needed.

2.12 AERATION CONTROL PANEL AND AERATION INSTRUMENTATION

A. The blower manufacturer shall be responsible to provide the following:
1. Aeration Control Panel (ACP) per Section 13491 – Process Control Descriptions
2. Basin Flow Control Valves as specified herein.
3. Flowmeters per Section 13420 – Primary Sensors and Field Instruments
4. DO probes per Section 13420 – Primary Sensors and Field Instruments
5. Venturi meters per Section 13420 – Primary Sensors and Field Instruments
6. Automatic process air control system per Section 13491 – Process Control Descriptions

2.13 TOOLS AND SPARE PARTS

A. Furnish and deliver the following tools and spare parts carefully boxed and labeled:
1. Blowers:
a. One complete set of bearings for blower and lube oil pump for each blower.
b. Two sets of all gaskets and seals for blower and oil pumps for each blower.
c. Two sets of oil pressure switches and oil filter cartridges for each

blower.

d. One spare main oil pump and one spare auxiliary oil pump.

2. Motors:
   a. One complete set of bearings for each motor.
   b. One set of all gaskets and seals for each motor.
   c. One spare flexible coupling for electric drive and blower.
3. Two sets of any special tools required for normal operation and maintenance.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

C. Manufacturer shall furnish a list of additional recommended spare parts for an operating period of one year. The list shall describe each part, the quantity recommended, and the unit price of the part.

2.14 SHOP PAINTING

A. Prepare surface and prime coat ferrous metal surfaces of equipment in the shop in accordance with the requirements of Section 09900, Painting. Blowers, blower skids, and blower accessories shall be factory primed and painted.

2.15 LUBRICANTS

A. Furnish and install oil and grease required for initial operation. Furnish oil and grease required for first oil change and for second round of grease lubrication. Products shall be as recommended by the manufacturer.

2.16 SOURCE QUALITY CONTROL

A. Source Quality Control:
   1. Blower Shop Witness Tests:
      a. Test each blower at a minimum of five operational points including the primary performance point the 70 percent capacity point and the maximum turndown point as specified below and in accordance with applicable requirements of the ASME PTC 13. No other test method is acceptable. The test results shall be reported in accordance with this code.
      b. Use the project motor for testing of electric motor driven blowers.
      c. All gauges and other test instruments shall be calibrated within 30 days of the scheduled test dates and certified calibration data shall be provided.
      d. Average power consumption as defined in paragraphs 1.3.D and 2.1.C shall be verified and met within +/-0% tolerance. Unit shall be reworked until average power consumption detailed in Paragraph 2.1.C is met.

e. Record vibration levels of the housing and the shaft of the unit during a minimum of six test points. Filtered vibration taken on the housing or bearing caps shall not exceed 0.1-inch per second. The double amplitude of vibration in any plane measured on the shaft adjacent and relative to each radial bearing shall not exceed the following value or 2.0-mils, whichever is less:

$$\text{Allowable unfiltered vibration including runout} = 1.25 \times \frac{\sqrt{12{,}000}}{\sqrt{N}}$$

Where , N = maximum impeller speed.

f. Temperature of the bearing contact surfaces near the end of the test run shall not exceed 215°F.

g. Hydrostatically test blower casing at a minimum test pressure of 25 psig for a duration of half hour. Provide a certification of this test. The casing shall be left unpainted during the performance and pressure tests. The magnetic particle test, if used, shall be in accordance with ASTM E 109.

h. Test the impeller in excess of 120 percent of the design speed, after which it shall be carefully inspected for defects by the Zyglo method or equivalent.

i. Perform a shop test for sound pressure level. Tests and decibel ratings shall be in conformance with ANSI S5.1. The overall sound pressure level shall be taken at points evenly spaced around each blower and motor assembly and at five feet from the nearest part of the units.

j. Each test shall be witnessed by representatives of the OWNER and/or ENGINEER and by a Registered Professional Engineer, who may be an employee of the manufacturer. The Registered Professional Engineer shall certify that all required tests were performed. The Registered Professional Engineer's certification shall show state of their registration, registration number and name on the seal shall be clearly legible. Certification shall show the serial numbers of all equipment tested. If the results of these tests indicate that the blowers do not meet the requirements of these Specifications, they shall be modified and re-tested until they do. If the blowers do not meet the specified maximum power draw, OWNER reserves the right to reject the blowers or to accept the blowers at a lower cost to be determined as specified herein.

2. Motor Tests:

a. All motors shall be completely assembled at the factory and shall be given routine tests conducted in accordance with NEMA MG1-20.46 which includes the following tests:

1) No load current.

2) Winding resistance.

3) High potential dielectric tests.

b. Each motor shall have its efficiency tested in accordance with IEEE 112.

Efficiencies shall be determined at 1/2, 3/4, and full load.

c. The following additional tests shall be conducted in accordance with NEMA MG1.
   1) Temperature rise.
   2) Percent slip.
   3) Check current balance.
   4) Measure air gap.
   5) Locked rotor pull-up and break-down torque.
   6) Pull out torque (calculated from locked rotor test).
   7) Power factor at full, 3/4, and 1/2 load.
   8) Bearing inspection.
   9) Resistance of armature and field.
   10) Polarity of field coils.
   11) High-potential test on field and armature.
   12) Starting characteristics including starting and accelerating torque, and current by the reduced voltage method.

d. Conduct a no-load noise test in accordance with IEEE 85. Test results shall meet the requirements of this section.

e. Testing shall demonstrate that the vibration with the motor bolted to a steel floor, stator at design temperature, motor shaft extension with half-key, and lubrication at normal operating temperature shall not exceed 0.10-inch/second at rotational frequency and at all multiples through 120 Hz and one half of rotational frequency or 0.15-inch/second unfiltered. Vibration shall be as measured in any plane on bearing caps of both ends. Stator temperature for vibration tests may be accomplished by restricting cooling air flow or by other industry standard methods; however, the motor manufacturer shall evaluate all effects of the method of testing, and vibration readings shall be taken while air flow is not restricted. During the testing, the motor shall be complete and shall have nothing removed for convenience except the power lead conduit box.

f. Copies of the test results for each motor shall be certified by a responsible test engineer. The test results shall be furnished to OWNER for review before shipment of the motors.

3. Control Panel Tests:
   a. The control panels shall be tested in the factory in accordance with the requirements of Division 13.
4. Visual Inspection: Verify that equipment complies with these Specifications and approved Shop Drawings.
5. Packing:
   a. Inspect prior to packing to assure that assemblies and components are complete and undamaged.
   b. Protect machined surfaces and mating connections.
   c. Protect bearings and gearing with a shop applied corrosion prevention coating.

d. Cover all openings into gear boxes with vapor inhibiting and water repellent material.
e. Adequately crate to prevent damage during shipment, delivery and storage.
f. Identify crate contents on packing slip fastened to the outside of crate.

6. The Contractor shall include payment for individual transportation, lodging, and meals for four representatives of the OWNER and ENGINEER for the duration of each shop witness test.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall verify that structures, pipes and equipment are compatible.

B. Make adjustments required to place system in proper operating condition.

3.2 INSTALLATION

A. Manufacturer's representative shall check and approve the installation prior to operation. Manufacturer's representative shall field test and calibrate the equipment to assure that the system operates to the OWNER'S satisfaction.

3.3 FIELD PAINTING

A. Field painting shall conform to the requirements of Section 09900, Painting.

3.4 START-UP AND TEST

A. Perform operating tests to demonstrate that the equipment operates without excessive vibration and without exceeding the specified noise limits.

B. Make adjustments required to place equipment in proper operating condition.

C. Sound Tests:
1. Perform an overall sound-pressure level test on each blower. Test results shall be rated in decibels in accordance with ANSI S5.1.
2. Take the overall sound pressure level at points evenly spaced around the blower and motor assembly and at five feet from the nearest part of the units. Sound level shall not exceed 90 decibels at three-foot distance measured on the A-weighted scale.
3. It is the intent of this Section that the complete unit as finally installed shall not exceed the sound pressure level as specified herein. Manufacturers shall submit a statement as to the unit's conformance with the requirements of this Section, whether remedial measures will be required, and if so, what remedial measures they

propose.

4. CONTRACTOR shall provide all instruments, necessary labor, tools, and materials to conduct the field tests.

D. Submit report of test results.

3.5 FIELD QUALITY CONTROL

A. All equipment will be given running tests by CONTRACTOR at the job Site following installation of the equipment and controls. Should the tests indicate any malfunction, CONTRACTOR shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the ENGINEER, the installation is complete, and the equipment is functioning properly and accurately, and is ready for permanent operation.

B. A factory trained representative shall be provided for installation verification, commissioning, start- up and field test services, troubleshooting, acceptance testing, and operation and maintenance personnel training services for the blowers, blower controls, process air distribution system controls. The representative shall make a minimum of 15 visits, minimum 5 days for each visit for a total of 75 days, to the Site. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the equipment conforms to the specification requirements. The system shall be accepted upon completion of installation, field testing and a 14 day operational acceptance test. The Contractor and Manufacturer shall be responsible for operation and maintenance of the complete system during the 14 day acceptance test. The acceptance shall be considered successful when the system operates successfully in automatic mode for 14 days without any failure conditions or unplanned shutdowns. The system Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

C. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the OWNER.

+ + END OF SECTION + +

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SECTION 13101

LIGHTNING PROTECTION SYSTEM

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing lightning protection. Lightning protection systems shall be provided in accordance with the requirements specified under this section, the Contract Drawings and the Specifications.

1.2 RELATED SPECIFICATIONS

A. Specification 16061 - Grounding.

1.3 PAYMENT

A. Payment for lightning protection systems shall be in the lump sum bid item, No. 1.

1.4 REFERENCES

A. The lightning protection systems shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. NFPA 780, Standard for the Installation of Lightning Protection Systems.
   3. Lightning Protection Institute LPI 175, Standard of Practice.
   4. Lightning Protection Institute LPI 176, Standard of Materials.
   5. UL 96A, Standard for Installation Requirements for Lightning Protection Systems.
   6. UL 651, Standard for Schedule 40 and 80 PVC Conduit.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Prior to equipment submission, submit a list of proposed manufacturers with the products they produce for the Contract.
   2. Manufacturer’s catalog cuts and technical information for the lightning protection materials proposed for use.

3. Scaled working drawings showing proposed routing and layout of the lightning protection system with installation details.
4. Qualifications of proposed lightning protection contractor shall be submitted. Submit experience records at least 45 days in advance to equipment submittals. Five recent references with phone numbers shall be submitted.

C. Certificates of Compliance:
1. Certificates of LPI code compliance, together with UL master label C Certificate or letter of finding.

1.6 QUALITY ASSURANCE

A. All materials used in the installation shall be labeled or listed by UL for use in Master Labeled lightning protection systems. The completed system shall be in accordance with NFPA, LPI and UL 96A.

B. All materials shall be of stainless steel, copper and high copper- content bronze castings. In locations where system components are mounted on aluminum surfaces, aluminum materials shall be used to avoid electrolytic corrosion of the dissimilar metals.

C. Materials shall be sized in accordance with the material requirements of NFPA-780, UL96A and LPI 176. Materials shall comply in weight, size and composition for the class of structure to be protected. Class I materials shall be used for systems on structures not exceeding 75 feet in height and Class II materials shall be used for systems on structures exceeding 75 feet above grade.

D. A UL listed master labeled certification shall be provided. For hazardous areas, where a master label is not available, a letter of finding shall be obtained.

E. The Contractor shall retain the services of a lightning protection contractor who is regularly engaged in installing Master Labeled lightning protection systems. The lightning protection Contractor shall be a LPI certified master installer or inspector. Provide proof of the certification, or demonstrate that the standards and experience required for certification are possessed, all to the satisfaction of the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

A. Lightning protection system materials shall be delivered, stored and handled in accordance with the Specifications.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. The lightning protection system shall be manufactured by Heary Brothers Lightning Protection Company, Thompson Lightning Protection Company or equal to be approved by the Engineer.

2.2 COMPONENTS

A. All lightning protection system fittings shall be heavy duty type. All bolts, screws and hardware shall be stainless steel.

B. Ground rods shall conform to the requirements of Specification 16061 - Grounding.

C. Ground Cables:
   1. Ground cables shall be copper where necessary to prevent dissimilar metal reaction.
   2. Ground cable stranding, number and size shall be suitable for the classification of the structure to be protected. All ground cable where exposed shall be corrosion resistant.

D. Air terminals shall be stainless steel 5/8 inch diameter, eighteen inches long. Air terminals shall include a cast bronze point protector, stainless steel adapter and copper base.

2.3 NON-METALLIC CONDUIT AND FITTINGS

A. Non-metallic conduit shall be schedule 80 PVC plastic, 90 degrees C rated, conforming to UL No. 651.

B. Non-metallic fittings shall be of same material and manufacturer as base conduit. Cement shall be provided for joining fittings to the conduit and shall be the same manufacturer as the base conduit.

C. Non-metallic conduit and fittings shall be by Carlon, Amoco Chemicals Corporation or equal to be approved by the Engineer.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Main conductors shall be installed to provide a two-way path from each air

terminal horizontally or downward to connections with ground terminals.

B. Conductors shall be installed free of excessive splices and sharp bends. Conductor bends shall form an included angle of not less than 90 degrees nor have a radius of bend of less than 8 inches. Conductors shall be secured to the structure at intervals not exceeding 3 feet.

C. Down conductors where possible shall be concealed in the exterior wall construction. Down conductors shall be spaced at intervals averaging not more than 100 feet around the perimeter of the structure. In no case shall a structure have fewer than two down conductors.

D. In the case of structural steel frame construction, down conductors may be omitted and roof conductors shall be connected to the structural steel frame at intervals averaging not more than 100 feet around the perimeter of the structure. Connections to the steel frame shall be made with bonding plates having 8 square inches of contact or by exothermic weld connections.

E. Air terminals shall project a minimum of 10 inches above the area protected and shall be located at intervals not exceeding 20 feet along ridges and around the perimeter of flat or gently sloping roofs.

F. Flat or gently sloping roofs exceeding 50 feet in width, shall be protected with additional air terminals located at intervals not exceeding 50 feet in the flat or gently sloping area. Air terminals shall be located within 2 feet of roof edges and outside corners of protected areas. Air terminal spacing exceeding these dimensions, shall be permitted so long as the area protected lies within a zone of protection.

G. Air terminals shall be installed for stacks, flues, mechanical equipment, and other objects, having a metal thickness of less than 3/16 of an inch, and not located within a zone of protection. Objects having a metal thickness 3/16 of an inch or greater shall be connected to the lightning protection system.

H. Roof penetrations shall be installed using thru-roof assemblies with solid bars and appropriate roof flashing. Conductors shall not pass directly through the roof.

I. The system shall be installed with common grounding by interconnecting ground mediums entering the building using main size conductors and fittings. Grounded metal bodies shall be bonded to the system using bonding connections and fittings. Ground conductors where installed in conduit, shall be non - metallic type.

J. Ground electrodes shall be provided for each down conductor. The down conductor shall be connected to the ground rod using an exothermic welded connection. A bronze ground rod clamp having at least 1-1/2

inches of contact between the rod and the conductor, measured parallel to the axis of the rod shall be used at ground test wells.

3.2 FIELD INSPECTION

A. The Contractor shall have the master installer or inspector perform field inspection of the lightning protection system at several stages during the installation in accordance with LPI requirements.

B. Upon completion of the lightning protection system the Contractor shall arrange for a final inspection of the system. The final inspection shall be performed by the master installer or inspector in accordance with LPI requirements.

+ + END OF SECTION + +

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SECTION 13306

APPLICATIONS ENGINEERING SERVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for Programmable Automation Controllers (also identified as PAC, PLC or Programmable Logic Controllers) as required for the complete performance of the Work, as shown on the Drawings and as specified herein.

B. The Contractor shall procure the services of an Application Engineering Services Supplier (AESS) as part of this contract to coordinate the tie-in of all Aeration and Blower panels to the new Aeration Building Facility along with the AESS supplied equipment.

C. AESS shall supply the panels and equipment as shown on the contract drawings:

1. FOCE-ABF (SCADA Network Cabinet)
2. SCADA Workstation UWLISCADABPWS08 (Cimplicity SCADA client computer and UPS)
3. PLC-HVAC-ABF (SCADA PLC Cabinet with touchscreen OIT)

D. AESS shall coordinate with the contractor to integrate the following panels onto the GE Cimplicity Plant SCADA system. The following panels are to be provided by others than the AESS

1. PLC-ABF (Aeration Control Panel)
2. PLC-BCP-1 to PLC-BCP-5 (Blower Local Control Panel)

E. AESS shall coordinate with the contractor for connecting to the SCADA system the signals as shown on the contract drawings and in the I/O list. These panels are not supplied by the AESS.

1. Electrical MIMIC Panel.
2. MVABP
3. LVABP
4. LVP-1

F. All system components specified or shown on the Drawings shall be provided, as well as any ancillary or incidental equipment or devices, whether identified or not, required for a complete functioning system and allow full use of system capabilities.

G. Provide all engineering to tie-in new equipment as shown on the contract drawings and specifications to display, record, trend and alarm the new system Inputs and Outputs on the existing SCADA system and OIT located within PLC-HVAC-ABF.

H. The PLC symbols or tag names shall follow the standards and conventions documentation which may be obtained from the Owner.

I. Provide configurations of the operator interface terminals (OITs) shown on the system architecture at PLC-HVAC-ABF. All alarm functions, setpoints, control functions, and monitoring signals for the HMI system shall also be included in the OITs with the exception of any excluded on the I/O lists.

J. Update the existing Plant SCADA for the modified and new equipment.

1. Update the HMI to match the revised MCP-1 control panel.
2. Update the existing Aeration and Blower screens for the new points from the PLC-AER and associated control panels.
3. Update the Networking Monitoring screens to include the new managed Ethernet switches provided under this contract including FOCE-ABF and MES-HVAC-ABF.
4. Update the UPS Monitoring screens to include the new UPS units under this contract.

K. Updates to Ethernet Network.

1. Update all existing plant Perdue Model documentation for new networking equipment, IP addresses, Port Assignments, VLANs and other related networking additions.
2. Configure all existing and new managed Ethernet switches for IP Addresses, Port Assignments and VLANs.
3. Coordinate with all vendor supplied control panels to provide IP addresses, port assignments and any instructions for aligning vendor supplied network equipment with existing plant systems.

L. Modify the existing GE/Emerson Based Main Control Panel (MCP-1) and MCC-IO control panels within the Operations Building.

1. Remove all I/O field wiring associated with analytical devices removed from the Main Control Panel.
2. Remove the two remote I/O racks containing removed analytical devices in the MCP-1 panel from the PLC program.
3. Modify the existing GE/Emerson PLC to remove analytical devices no longer connected.
4. Supply a protocol converter as required for the GE/Emerson CPU to communicate to the PLC-ABF. Coordinate with PLC-ABF vendor for communication between the two PLCs.
5. Relocate the following devices from the MCP-1 to the MCC-IO panel so that the current MCP-1 panel can be abandoned and simplifying the system into one control panel instead of two:
    a. Redundant PLC system.
    b. Ethernet switches and cables as required.
    c. Necessary wiring, terminal blocks and related items.
    d. Connect the MCC-IO control panel to the existing Ethernet connection at FOCE-OPS utilized by the MCP-1.
6. Provide as-built drawings of the MCC-IO panel with the above modifications.

M. Add the Aeration Building Power Monitoring to the existing SCADA system. Connections from the Power Monitoring will be via Modbus/TCP protocol from the MIMIC panel to the FOCE-ABF.

N. Add the Aeration Building HVAC and general alarms connected to the PLC-HVAC-ABF panel to the existing plant SCADA system.

O. Coordinate with the vendor control panels for all tags that must be displayed on SCADA screens.

P. Related Sections: Related sections include, but shall not be limited to, the following:
1. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to Work of this Section.
2. In addition to the requirements specified herein, the requirements of specification Section 13401 Process Control System General Provisions, and the sections referenced therein shall apply to the work of this Section.
3. Process controllers shall include but not be limited to the inputs and outputs listed within specification Section 13480 Input Output Point List

4. Process controllers in conjunction with the Process Instrumentation and Control System shall include but not be limited to the functions specified within specification Section 13491 Process Control Descriptions.

5. Process controller types and configuration requirements are depicted on the Process Instrumentation and Control System drawings.

1.2 REFERENCES

A. General, Publications: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

1. 2014 Nassau County SCADA System Standards.
2. Canadian Standards Association (CSA)
    a. CSA E61131-2 Programmable Controllers – Part 2: Equipment Requirements and Tests
3. International Automation Association (ISA)
    a. ISA 71.04 Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants
    b. ISA RP 60.11 Crating, Shipping, and Handling for Control Centers
    c. ANSI/ISA-95 “Purdue Hierarchy” Enterprise-Control System Integration
4. International Electrotechnical Commission (IEC)
    a. IEC 60068 Environmental Testing
    b. IEC 60721 Classification of Environmental Conditions
    c. IEC 61000 Electromagnetic Compatibility (EMC)
    d. IEC 61131-2 Programmable Logic Controllers – Part 2 Equipment Requirements and Tests
    e. IEC 61131-3 Programmable Logic Controllers – Part 3 Programming Languages
    f. IEC 61850 Communication Networks and Systems for Power Utility Automation
5. National Fire Protection Agency (NFPA)
    a. NFPA 70 National Electrical Code (NEC)
    b. NFPA 79 Electrical Standard for Industrial Machinery
6. Underwriter Laboratories (UL)
    a. UL 508 – Industrial Control Equipment

1.3 DEFINITIONS

A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.

B. AESS - Application Engineering Services Supplier

1.4 SUBMITTALS

A. General: Submittals shall be in accordance with the requirements of Section 01720 Project Record Documents and Section 13401 Process Control System General Provisions, in addition to those specified herein.

1. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

2. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

B. Operation & Maintenance (O&M) manuals shall be provided in accordance with the minimum requirements specified in Section 01730 Operation and Maintenance Data, Electrical Requirements and additional requirements specified herein.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of ten years.

1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.

2. The manufacturer or their representative shall have service, repair, and technical support services available 24 hours 7 days a week basis.

3. The qualified manufacturer shall have within 75 miles of the Project site, a facility or an approved qualified representative capable of providing configuration, installation, startup, training, parts, and coordination of emergency maintenance and repairs.

4. The PLC manufacturer shall have in place a written policy establishing a commitment for product support for an extended period following the initial introduction of the product. The product life cycle policy shall provide for the following support:

    a. All new products will be available on active sale for a minimum of eight years or an equivalent replacement will be supplied.

    b. All products will be supported for a minimum of six years after it has been removed from active sale.

B. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Equipment, assemblies and materials shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.

B. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.

C. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

1.7 WARRANTY

A. General: Refer to 01760 Project Closeout.

B. Additional Owner Rights: The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents

and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

C. Warranty: The contractor shall provide a one (1) year warranty for the processors, input/output (I/O) systems, power supplies, racks, and communication interface. The warranty period shall commence on the date of the final testing. The terms of the warranty shall provide for replacement of defective components, free of charge, at any time during the warranty period.

1.8 VENDOR EQUIPMENT COORDINATION

A. AESS provider must coordinate all configurations of all communications that must be sent from vendor control panels to other equipment including vendor to vendor panels, vendor to AESS and vendor to SCADA.

B. Vendor supplied control panels:

1. Aeration Control Panel – PLC-ABF.
2. Blower Control Panels PLC-BCP-1, PLC-BCP-2, PLC-BCP-3, PLC-BCP-4 and PLC-BCP-5.
3. Power Monitoring MIMIC Panel.
4. AESS to provide updated Perdue Model spreadsheets for all networked equipment and to provide network diagrams of all supplied equipment with networked connections.

1.9 COORDINATION MEETINGS AND WORKSHOPS

A. Schedule and conduct a draft graphics review meeting. The purpose of this meeting shall be to present draft documents for the Owner's and Engineer's review and feedback prior to creating the full set of graphics for review. The draft graphics should be based on a combination of existing SCADA screens and vendor control panel OIT screens.

B. Schedule and conduct a historical data management and reports workshop. The purpose of this workshop shall be to discuss and solicit Engineer/Owner input for storage and management of historical data, format of daily, monthly and year reports, for the development of data entry templates, report formats and layouts, and user interface displays for accessing and generating reports. Bring examples of all these documents for review and discussion. The historical data management and reports will only be for systems supplied under this contract and to utilize the existing historical data and report infrastructure currently residing in the plant SCADA.

PART 2 - Modifications to existing systems.

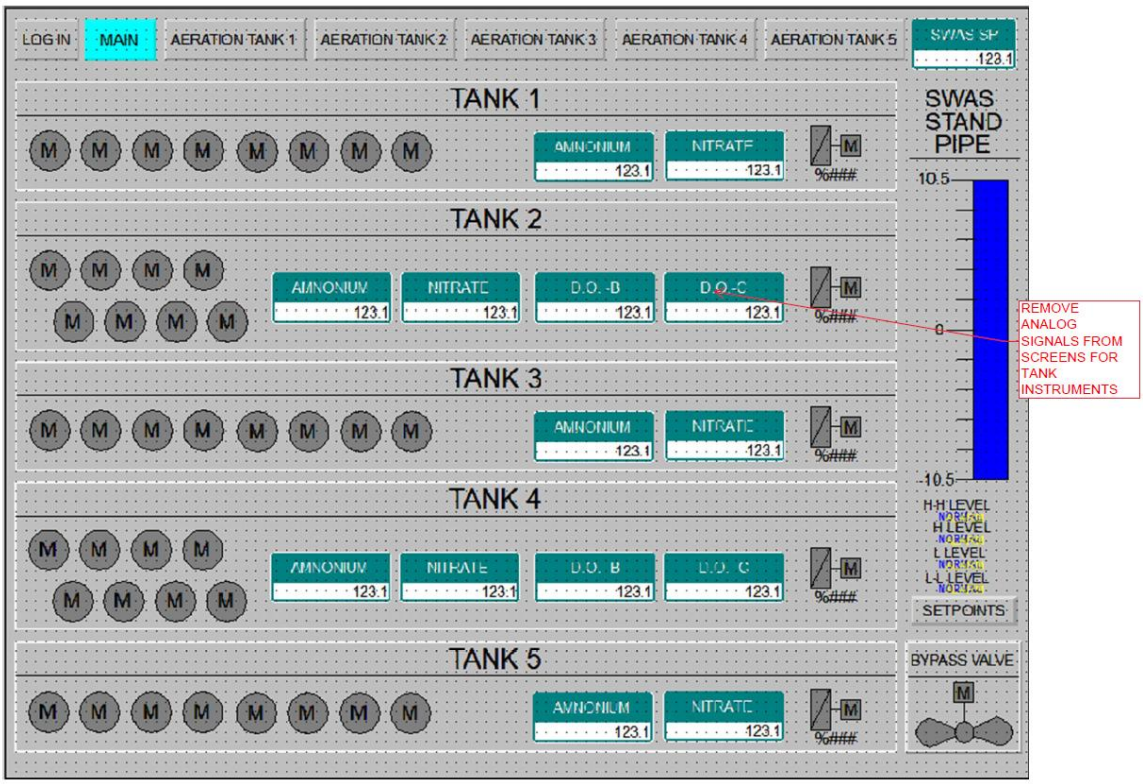
2.1 MAIN CONTROL PANEL (MCP-1) AND MCC-IO CONTROL PANEL (OPERATIONS BUILDING)

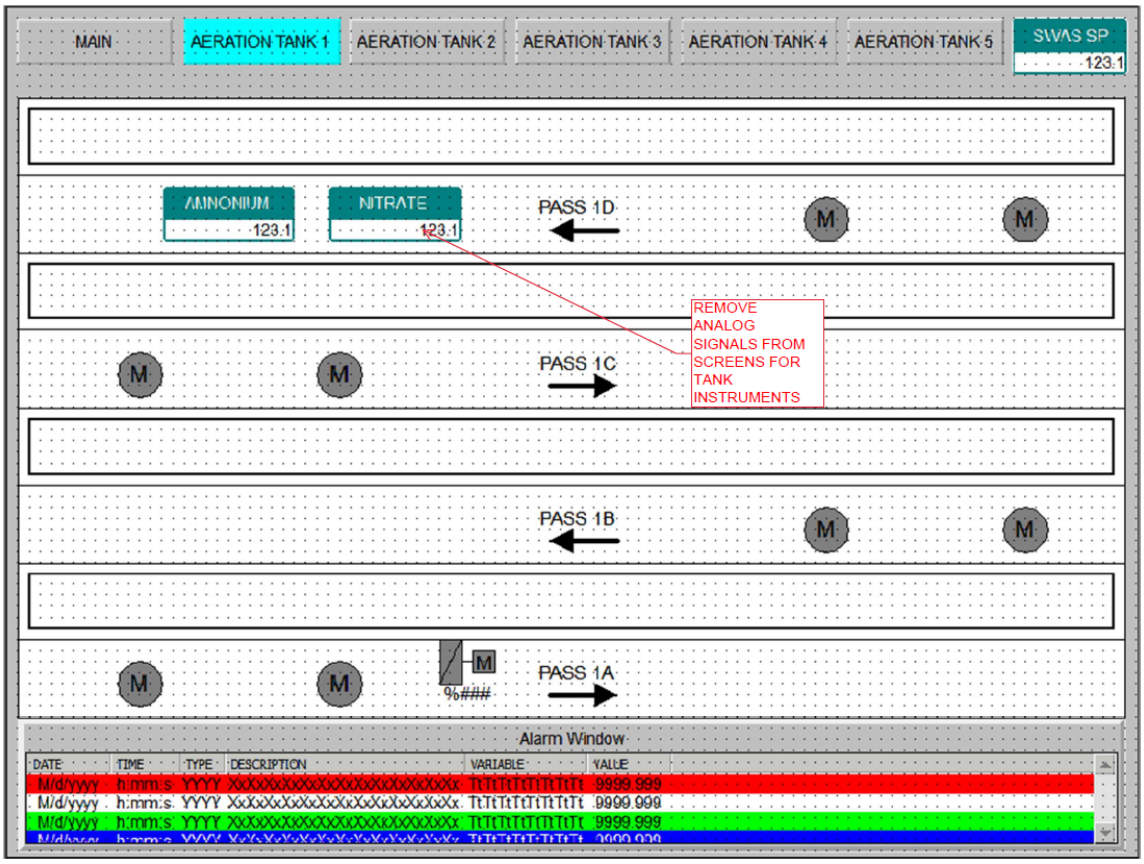
A. Existing Aeration Control System is comprised of a GE/Emerson based PLC system with a redundant PLC and I/O located in the “Main Control Panel” otherwise known as the MCP-1 along with a remote I/O panel “MCC-IO” with both communicating to each other via a redundant Profinet ring.

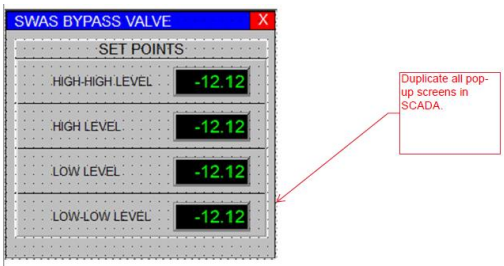
B. Modifications required are detailed in 13306 1.1.

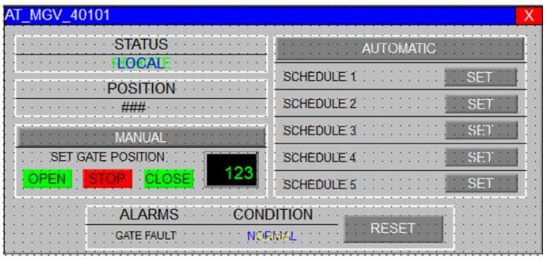
C. Shop drawings shall be provided upon request by the contractor to the owner.

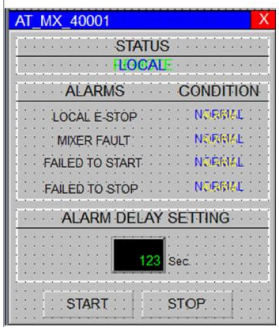
D. Existing panel drawings and OIT screenshots with notes for changes:

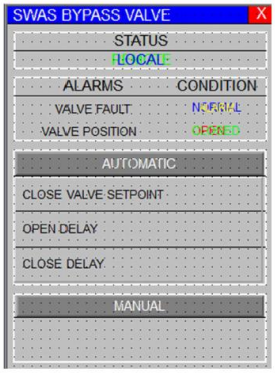



MAIN
AERATION TANK 1
AERATION TANK 2
AERATION TANK 3
AERATION TANK 4
AERATION TANK 5
SWAS SP
123.1
AMMONIUM
123.1
NITRATE
123.1
PASS 1D
PASS 1C
PASS 1B
PASS 1A
M
%###
REMOVE ANALOG SIGNALS FROM SCREENS FOR TANK INSTRUMENTS
Alarm Window
DATE
TIME
TYPE
DESCRIPTION
VARIABLE
VALUE
M/d/yyyy h:mm:s YYYY 9999.999

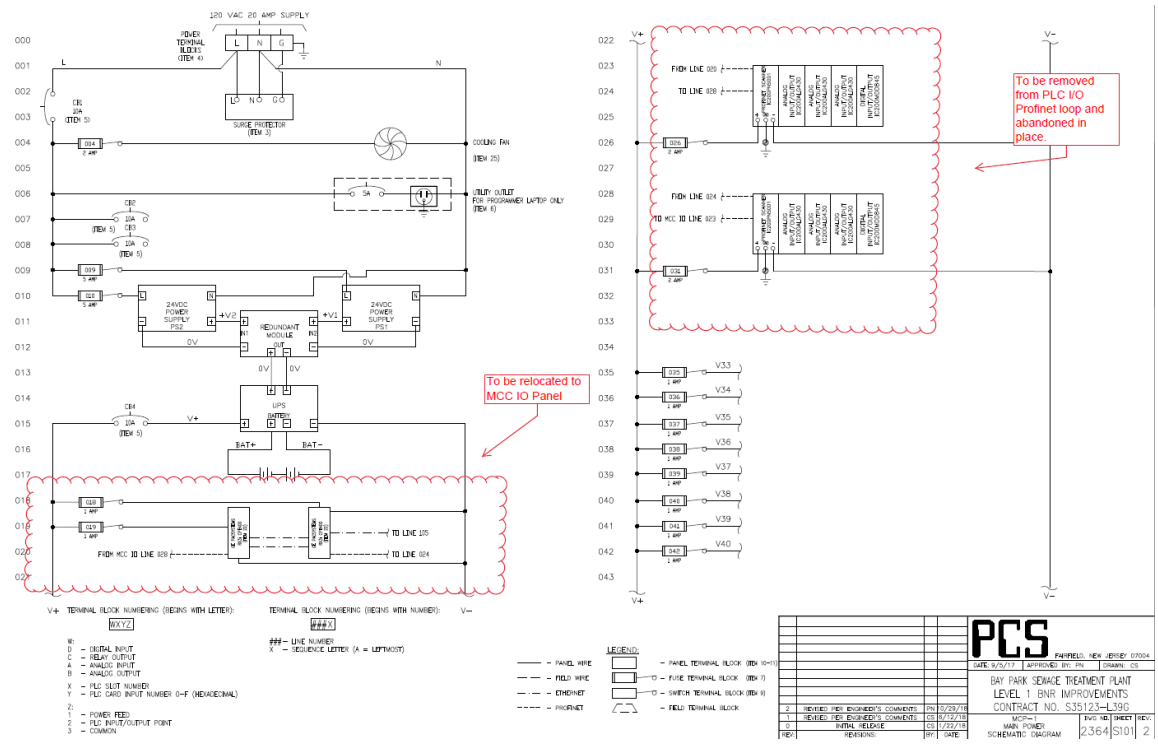

SWAS BYPASS VALVE
SET POINTS
HIGH-HIGH LEVEL
-12.12
HIGH LEVEL
-12.12
LOW LEVEL
-12.12
LOW-LOW LEVEL
-12.12
Duplicate all pop-up screens in SCADA.

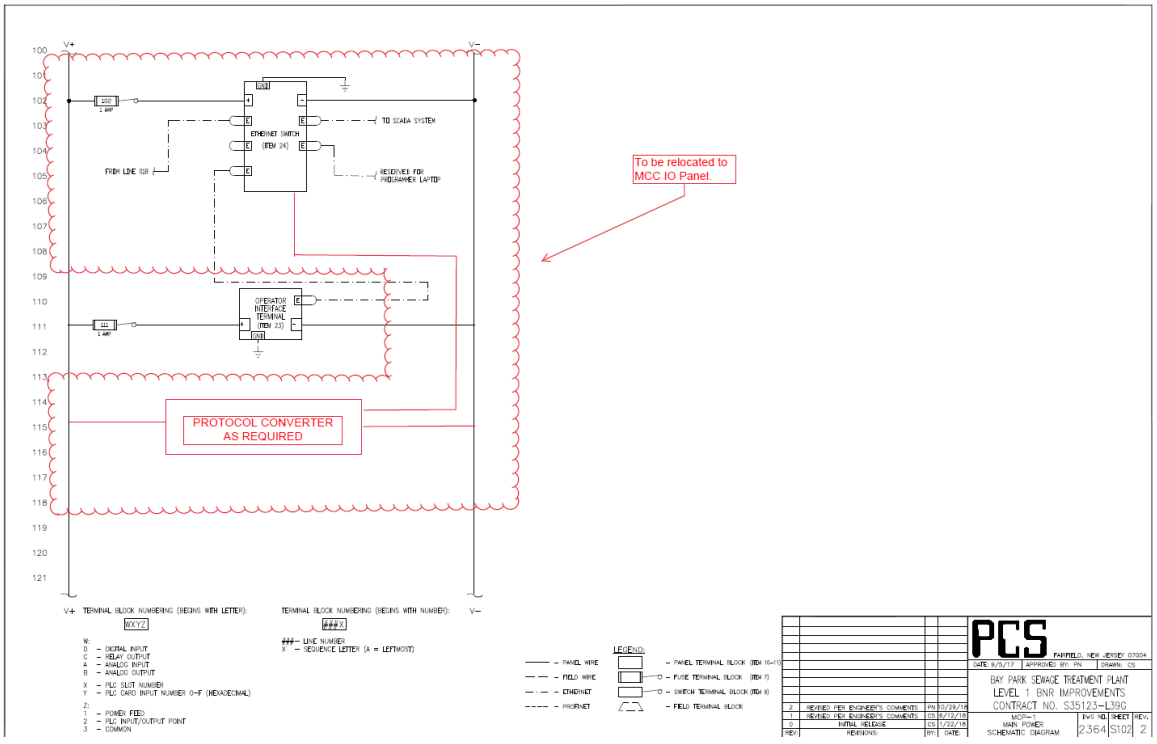

AT_MGV_40101
STATUS
LOCAL
POSITION
###
MANUAL
SET GATE POSITION
OPEN
STOP
CLOSE
123
AUTOMATIC
SCHEDULE 1
SCHEDULE 2
SCHEDULE 3
SCHEDULE 4
SCHEDULE 5
SET
ALARMS
CONDITION
GATE FAULT
NORMAL
RESET

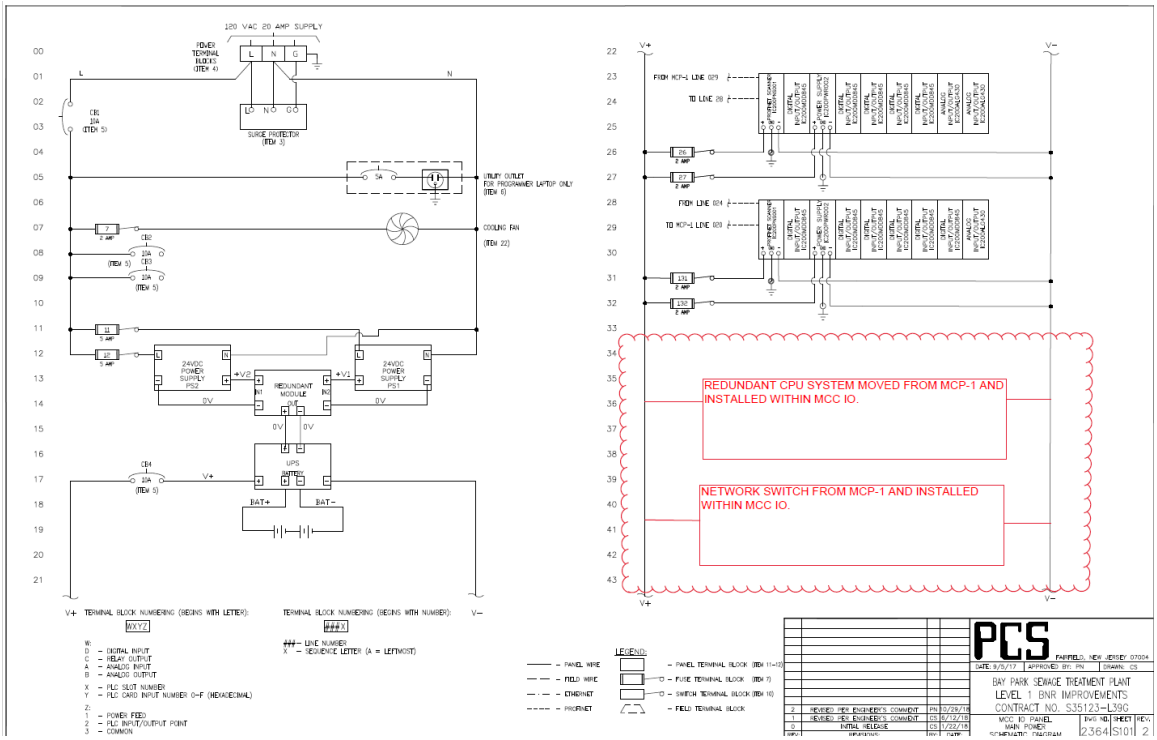

AT_MX_40001
STATUS
LOCAL
ALARMS
CONDITION
LOCAL E-STOP
MIXER FAULT
FAILED TO START
FAILED TO STOP
NORMAL
ALARM DELAY SETTING
123
Sec.
START
STOP


SWAS BYPASS VALVE
STATUS
LOCAL
ALARMS
CONDITION
VALVE FAULT
NORMAL
VALVE POSITION
OPENED
AUTOMATIC
CLOSE VALVE SETPOINT
OPEN DELAY
CLOSE DELAY
MANUAL


TANK1 SCHEDULE 1
OPEN TO
123
TIME SCHEDULE
OPEN AT
1234
Min.
CLOSE AT
1234
Min.
SET ACTIVE


120 VAC 20 AMP SUPPLY
To be removed from PLC I/O Profinet loop and abandoned in place.
To be relocated to MCC IO Panel
LEGEND:
PCS
BAY PARK SEWAGE TREATMENT PLANT
LEVEL 1 BNR IMPROVEMENTS
CONTRACT NO. S35123-L39G
MCP-1
MAIN POWER
SCHEMATIC DIAGRAM
2364 S101 2


To be relocated to MCC IO Panel.
PROTOCOL CONVERTER AS REQUIRED
LEGEND:
PCS
BAY PARK SEWAGE TREATMENT PLANT
LEVEL 1 BNR IMPROVEMENTS
CONTRACT NO. S35123-L39G
MCP-1
MAIN POWER
SCHEMATIC DIAGRAM
2364 S102 2



PART 3 - EXECUTION

3.1 GENERAL

A. The system specified herein shall perform the following generalized functions:

1. Monitor equipment per the I/O lists.
2. Collect, calculate and store accurate, reliable operating information for present and future uses.
3. Accumulate and store equipment running times for use in preventative maintenance.
4. Provide color graphic displays and reports for use by the system operating and supervisory personnel.
5. Provide trending for all necessary analog values.
6. Provide control system diagnostics.
7. All process control functions including PID, calculations, sequencing, timing, etc., shall be done in the process controller. The HMI software shall perform the real-time database report generation, graphic screens, program development, set point modification, data archiving, etc.

8. The system shall allow the operator to manually control (by keyboard entry and mouse type pointing device) the status of pumps, valves, etc. (i.e., on off, opened, closed, setpoint value, etc.) when viewing the appropriate graphic screen on the HMI.

B. Collect, calculate and store accurate, reliable operating information for present and future uses.

3.2 SPECIFIC GRAPHIC SCREENS

A. At a minimum, provide the following types of graphic screens indicated below on the existing Plant SCADA:

1. Plant Overview – Modified of the existing.
2. Main Menu (Index) – Modified of the existing.
3. Aeration – Modification of the existing screens.
4. Blowers – Modification of the existing screens.
5. HVAC and related building equipment.
6. Power Monitoring and related equipment.

++ END OF SECTION ++

SECTION 13401

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up and place in satisfactory operation a complete Process Control System (PCS).

2. The process instrumentation and control Work includes, but is not limited to, the following:

   a. Aeration Control System, supplied by the Blower Manufacturer (see Section 11610, Integrally Geared Single-Stage Centrifugal Blowers)

   b. SCADA Integration of the new PCS for the new Blower Facility, which includes SCADA integration of the Aeration Control System and all other control and monitoring functions as shown in the Contract Documents

B. PCS shall monitor, store, display, and log process and equipment operating information; perform various process control functions; and generate various reports.

C. The Contract Documents describe the required PCS and PCS functions and operational requirements.

1.2 COORDINATION REQUIREMENTS

A. Process Controls:

1. Providing central computer system, instruments, and controls are part of the Work by instrumentation and controls (I&C) Supplier. Programming of control logic and configuration of human machine interface (HMI) software is part of the Work. The I&C Supplier shall program and configure the software by procuring the services of an Application Engineering Services Supplier (AESS). Functional description of process system and associated equipment is included in Section 13491, Process Control Descriptions.

2. Some panels and equipment are furnished under other Specification Sections under this Contract. Coordinate with Suppliers of these panels and equipment to provide fully functional system in accordance with the Contract Documents and that interfaces with central computer system.

3. Computer system input/output list identifies inputs and outputs required and is part of this Section. Input/output list is for coordinating signals between equipment provided by other Suppliers and identifying signals to be programmed by the AESS. Provide Work for Contractor-furnished control options not on the input/output list at no additional cost to OWNER.

B. To centralize responsibility, I&C materials and equipment provided under this Contact shall be furnished by a single Supplier.

C. With Contractor, I&C Supplier shall assume the responsibility for adequacy and performance of materials and equipment provided under this Section.

D. To the greatest extent possible, provide I&C materials and equipment from a single manufacturer.

E. Supplier's Responsibilities:

1. Preparing all process control equipment submittals in accordance with the Contract Documents.

2. Proper interfacing of instrumentation and control equipment with field equipment, instruments, devices, and panels, including required interfacing with packaged control systems furnished by other equipment Suppliers, and required interfacing with the Site's electrical system.

3. Review and coordination with manufacturers, other Suppliers, and other contracts of Shop Drawings and other Contractor submittals for equipment, valves, piping, and appurtenances for ensuring proper interfacing of hardware, and locations and installation requirements of inline devices and instrument taps.

4. Direct, detailed oversight of installation of instruments, panels, consoles, cabinets, wiring and other components, and related wiring and piping connections.

5. Calibrating, source quality control, field quality control, and start-up of the system.

6. Responsibility for correction period obligations for the PCS.

7. Training operations and maintenance personnel in operation and

maintenance (including calibration and troubleshooting) of the PCS.

1.3 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/ASQ Z1.4, Sampling Procedures and Tables For Inspection By Attributes.
2. ASTM A269, Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
3. ASTM A312, Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
4. ASTM A403, Specification for Wrought Austenitic Stainless Steel Piping Fittings.
5. IEEE 802.1X, Port Based Network Access Control.
6. IEEE 802.3, Standards Defining Physical Layer and Data Link Layer Media Access Control (MAC) Sublayer of Wired Ethernet
7. ISA 5.1, Instrumentation Symbols and Identification.
8. ISA 5.4, Instrument Loop Diagrams.
9. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
10. NFPA 70 (NEC), Article 770, Optical Fiber Cables and Raceways.
11. NFPA 79, Electrical Standard for Industrial Machinery.
12. UL 50, Safety Enclosures for Electrical Equipment, Non-Environmental Considerations.
13. UL 508A, Industrial Control Panels.

B. Related Sections:

1. Section 11610, Integrally Geared Single-Stage Centrifugal Blowers
2. Section 13306, Applications Engineering Services
3. Section 13491, Process Control Descriptions.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. I&C Supplier:

   a. Shall be financially sound with at least five years of continuous experience in designing, implementing, supplying, and supporting process control systems for municipal wastewater treatment facilities comparable to PCS required for the Project, relative to hardware, software, cost, and complexity.

   b. Shall have record of successful process control system equipment installations. Upon Engineer's request, submit record of experience for at least five projects, each with the following information: project name, owner name and contact information, name and contact information for contractor, name and contact information for engineer or architect, approximate and contract value of process control systems Work for which Supplier was responsible.

   c. Shall have at time of Bid experienced engineering and technical staff capable of designing, supplying, implementing, and supporting the instrument and control system and complying with submittal and training requirements of the Contract Documents.

   d. Shall be capable of training operations and maintenance personnel in PCS applications, and in operating, programming, and maintaining the control system and equipment.

   e. Shall have UL-approved panel shop.

   f. Possess a thorough, working knowledge of wastewater treatment processes and control philosophy in accordance with standard practices of the wastewater treatment industry.

   g. Possess and maintain a documented program of failure analysis.

2. Manufacturers: Manufacturers of instrumentation and control equipment furnished for the PCS shall be experienced producing similar equipment and shall have the following qualifications:

   a. Shall manufacture instrumentation and control system components that are fully-developed, field-proven, and of standardized designs.

   b. Shall have system of traceability of manufactured unit through production and testing in accordance with ANSI/ASQ Z1.4.

   c. Shall have guaranteed availability clause (99.99 percent, minimum for one year) for microprocessor-based components and appurtenances.

d. Shall have documented product safety policy relevant to materials and equipment proposed for the Work.

B. Component Supply and Compatibility:

1. PCS components shall be furnished by a single Supplier who shall have responsibility for furnishing a complete and integrated system.

2. Supplier who shall have responsibility for adequacy and performance of all items furnished.

3. Supplier shall prepare, or shall review and approve, all Shop Drawings and other submittals for the PCS.

C. Pre-submittal Conference

1. Schedule and conduct pre-submittal conference for instrumentation and control system within 15 days after acceptance of I&C Subcontractor by OWNER.

2. Required attendance for pre-submittal conference: Contractor, I&C Supplier, Engineer, and OWNER. Pre-submittal conference will be 2 hours. Conference will be held at Bay Park Water Pollution Control Plant unless otherwise acceptable to the entities attending.

3. Purpose of pre-submittal conference is to review manner in which I&C Subcontractor and I&C Supplier intend to comply with requirements of the Contract Documents relative to PCS submittals before submittals are prepared.

4. Bring to pre-submittal conference list of proposed personnel committed to assignment to the Project. List shall include I&C Supplier project manager, project engineer, field representative, local service representative, and sales representative(s). Indicate addresses of personnel not based at Subcontractor's and Supplier's office nearest to the Site.

5. Prepare items listed below for presentation at pre-submittal conference. Submit information to Engineer two weeks prior to pre-submittal conference.

a. List of materials and equipment required for PCS, and manufacturer and model proposed for each item.

b. List of currently-known requests for interpretations of which Contractor and I&C Supplier are currently aware.

c. List of proposed exceptions to the Contract Documents along with

brief explanation of each.

d. Proposed PCS network architecture diagram.

e. Sample of each type of process control submittal required by the Contract Documents. These may be submittals prepared for other projects.

f. Flow chart showing steps to be taken in preparing and coordinating PCS submittals.

g. General outline of types of tests to be performed to verify that all sensors and transducers, instruments, and digital processing equipment are functioning properly.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

a. Field Instruments:

(1) Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.

(2) Instrument tag number in accordance with the Contract Documents.

(3) Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.

(4) Description of construction features.

(5) Performance and operation data.

(6) Installation, mounting, and calibration details; instructions and recommendations.

(7) Service requirements.

(8) Dimensions of instruments and details of mating flanges and locations of closed tanks, pipe sizes for insertion instruments, and upstream/downstream straight run pipe lengths required.

(9) Range of each device and calibration information

(10) Descriptions of materials of construction and listing of NEMA ratings for equipment

b. Panels, Consoles, and Cabinets:

(1) Layout drawings that include:

(a) Front, rear, and internal panel views to scale.

(b) Tag number and functional name of components mounted in and on panel, console, or cabinet, as applicable.

(c) Product information on panel components.

(d) Nameplate location and legend including text, letter size and colors to be used.

(e) Location of anchorage connections.

(f) Location of external wiring and piping connections.

(g) Mounting and installation details, coordinated with actual application.

(h) Proposed layouts and sizes of operator interface graphic display panels and alarm annunciator panels.

(i) Calculations for heating and cooling of panels

(j) Subpanel layouts and mounting details for items located inside control panels.

(2) Product information on panel components including:

(a) Manufacturer's product name and complete model number of devices being provided, including manufacturer's name and address.

(b) Instrument tag number in accordance with the Contract Documents.

(c) Data sheets and catalog literature. Submit data sheets as shown in ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data

sheets with format similar to ISA 20.

(d) Description of construction features.

(e) Performance and operation data.

(f) Installation, mounting, and calibration details; instructions and recommendations.

(g) Service requirements

(3) Wiring and piping diagrams, including the following:

(a) Name of each panel, console, or cabinet.

(b) Wire sizes and types.

(c) Pipe sizes and types.

(d) Terminal strip and terminal numbers.

(e) Wire color coding.

(f) Functional name and manufacturer's designation for components to which wiring and piping are connected.

(g) Lightning and surge protection grounding.

(4) Electrical control schematics in accordance with NFPA 79. Drawings shall be in accordance with convention indicated in Annex D of the NFPA 79. Typical wiring diagrams that do not accurately reflect actual wiring to be furnished are unacceptable. Tables or charts for describing wire numbers are unacceptable.

(5) Stock list or bill of materials for each panel including tag number, functional name, manufacturer's name, model number and quantity for components mounted in or on the panel or enclosure.

(6) Detail showing anchorage plan of wire bundles between subpanels and front panel mounted devices.

c. Field wiring and piping diagrams, include the following:

(1) Wire and pipe sizes and types.

(2) Terminal numbers at field devices and in panels.

(3) Fiber optic termination designations in the field and in panels.

(4) Color coding.

(5) Conduit numbers in which wiring will be located.

(6) Locations, functional names, and manufacturer's designations of items to which wiring or piping are connected.

d. Proposed operator interface graphics layouts. Each graphic display and process report layout will be subject to modification from Contractor's submitted format within limits of software package used for development. Implement such modifications in accordance with Engineer's written comments on the submittal.

e. Process Control System:

(1) Submit the following general information:

(a) Detailed block diagram showing system hardware configuration and identifying model numbers of system components.

(b) Software listings for operating system, applications, and OIT.

(c) Software language and organization.

(d) OIT interfacing details, licensing structure, and included functions.

(e) Control and failure modes.

(f) Online and offline capabilities for programming, system utilities, and diagnostics.

(g) Input/Output Information:

(h) Input/output (I/O) point listing with I/O module cross-reference identification.

(i) I/O module cross-reference identification based on I/O address list developed by I&C Subcontractor.

(j) Database listing, including all I/O points.

(k) Suggested detailed format and configuration of log reports, alarm summaries, printer outputs, displays, and graphics.

(2) Hardware:

(a) Layout drawings showing front, rear, end and plan views to scale of equipment, I/O components, power supplies, and peripheral devices.

(b) Equipment ventilation requirements.

(c) Interconnection diagrams, including termination details, cable identification list, and cable length.

(d) Drawings showing equipment layout.

(e) Installation requirements, instructions, and recommendations.

(3) Software:

(a) Licensing agreement with name of licensee, renewal requirements, release and versions, expiration dates (if any) and upcoming releases scheduled before Project completion. When upcoming releases are expected, provide descriptions, when available, of features that differ from the proposed release.

(b) Standard technical and instructional documentation covering software for utility, system support, system documentation, display, communications, data logging and storage and diagnostic functions. Submit this information on electronic media.

(c) Standard technical documentation covering all aspects of the computer system software functions and capabilities, including instruction set description and programming procedures related to monitoring, display, logging, reporting and alarming functions.

(4) Documentation describing memory type, size and structure and listing size of system memory, I/O and Data Table memory and size of memory available for control programs.

(5) System I/O Loop Wiring Diagrams: Prepare Shop Drawings on a module-by-module basis based on Input/Output list and include the following information:

(a) Rack numbers, module type and slot number, and module terminal point numbers. Include location and identification

of intermediate panel and field terminal blocks and terminal numbers to which I/O wiring and power supply wiring is connected. Identify power supply circuits with designation numbers and ratings.

(b) Wiring types, wire numbers, and color coding.

(c) Designation of conduits in which field I/O wiring will be installed.

(d) Location, functional name, tag numbers and manufacturer's module numbers of panel and field devices and instruments to which I/O wiring will be connected.

(e) Prepare loop wiring diagrams in accordance with ISA 5.4.

f. Complete point-to-point interconnection wiring diagrams of field wiring associated with the system. Diagrams shall include the following:

(1) Field wiring between each equipment item, panel, instruments, and other devices, and wiring to control stations, panelboards, and motor starters. Some of this equipment may be specified in other Divisions, Contractor is responsible for providing complete point-to-point interconnection wiring diagrams for control and monitoring of that equipment.

(2) Numbered terminal block and terminal identification for each wire termination.

(3) Identification of assigned wire numbers for interconnections. Assign each wire a unique number.

(4) Schedule showing the wiring numbers and the conduit number in which the numbered wire is installed.

(5) Junction and pull boxes through which wiring will be routed.

(6) Identification of equipment in accordance with the Contract Documents.

2. Product Data:

a. Product data for panels, consoles, and cabinets in accordance with requirements for Shop Drawings in this Section.

b. Product data for field wiring and piping provided for instrumentation

and control service and not included under other Sections or contracts.

c. Product data for PCS, including software and hardware. Requirements for software product data are included in requirements for Shop Drawings under this Section.

3. Factory Acceptance Test Procedure: Submit factory testing procedures that will be performed to fulfill requirements of the Contract Documents. Test procedure shall include the following:

a. Visual inspection of components and assembly.

b. Description of hardware operational testing.

c. Description of software demonstration.

d. Description of testing equipment to be used.

e. Sign-off sheets to be used at time of testing.

B. Informational Submittals: Submit the following:

1. Documents to be submitted prior to pre-submittal conference, in accordance with Article 1.3 of this specification.

2. System Software Documentation: Submit preliminary software documentation not later than 28 days prior to scheduled start of factory testing. Software documentation shall include the following:

a. Complete printed copies of all programming.

b. Complete listing of external and internal I/O address assignments, register assignments and preset constant values with function point descriptions. List unused/undefined I/O and data table registers available.

c. Copies of all configured HMI screens.

3. Manufacturer's Instructions:

a. Shipping, handling, storage, installation, and start-up instructions.

b. Templates for anchorage devices for materials and equipment that will be anchored to concrete or masonry.

4. Source Quality Control Submittals:

a. Results of factory testing.

5. Special Procedure Submittals:

   a. Notification to OWNER and Engineer at least 14 days before readiness to begin system checkout at the Site. Schedule system checkout on dates acceptable to OWNER and Engineer.

   b. Written procedure for system checkout. Submit not less than 90 days prior to starting system checkout.

   c. Ninety days prior to starting system checkout submit written procedure for start-up.

6. Field Quality Control Submittals:

   a. Submit the following prior to commencing system checkout and start-up.

   b. Completed calibration sheets for each installed instrument showing five-point calibration (zero, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.

   c. Field calibration reports

   d. Field testing reports.

7. Supplier's Reports:

   a. Installation inspection and check-out report.

   b. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.

8. Qualifications Statements:

   a. I&C Supplier.

   b. Manufacturers, when required by Engineer.

C. Closeout Submittals: Submit the following:

1. Operations and Maintenance Data:

   a. Include complete up-to-date system software documentation. Provide hardcopy and electronic copies.

b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.

2. Record Documentation:

a. Prepare and submit record documents in accordance with Section 01720, Project Record Documents.

b. Revise all system Shop Drawing submittals to reflect as-built conditions in accordance with the following.

(1) Two copies of each revised Shop Drawings and documentation to replace out-dated drawings and documentation contained in operation and maintenance manuals. Submit half-size black line drawings for each drawing larger than 11 inches by 17 inches. Include specific instructions for out-dated drawing removal and replacement with record documents submittal.

(2) Half-size black line prints of wiring diagrams applicable to each control panel shall be placed in clear plastic envelopes and stored in a suitable print pocket or container inside each control panel.

(3) Submit CADD drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.

c. Provide complete configuration data for all configurable devices.

D. Maintenance Materials Submittals: Submit the following:

1. Spare Parts and Test Equipment

a. General

(1) Furnish the spare parts and test equipment as indicated below, identical to and interchangeable with similar equipment provided under this Section.

(2) Provide source quality control for spare parts as part of factory testing prior to shipment of control equipment.

(3) For process sensors and other analog instruments, Supplier shall submit a separate quotation for recommended list of spare parts and test equipment. Separately list and price each item recommended. Spare parts quotation shall include a statement that prices quoted are valid for a period of one year from date of

equipment installation and that Supplier understands that OWNER reserves the right to purchase none, any, or all parts quoted. Upon request, Supplier shall submit documentation that stock of spare parts and test equipment is obtainable within 48 hours of receipt of OWNER's order.

b. Furnish the following spare parts:

(1) Five of each type of relay for each quantity of forty or fraction thereof provided under the Contract.

(2) One of each type of PLC communication cables.

(3) Two of each type of PLC processors.

(4) One of each type of Communication module.

(5) One of each type of redundant module and accessories.

(6) Two of each type of PLC input/output module or card used with accessories.

(7) Two of each type of PLC power supply.

(8) One of each type of PLC chassis.

(9) One of each type of OIT.

(10) Two replacement 24 vdc power supply for each type and size provided under the Contract.

(11) One-year supply of all expendable or consumable materials.

(12) Twelve of each type and size of fuse used in instruments.

c. Furnish the following test equipment:

(1) One Fluke or equal (latest in series) digital Process meter with signal simulators (four to 20 mA DC; zero to ten VDC), test leads, case, and other recommended spares and accessories.

(2) One RTD calibrator, including case.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prior to packaging, each manufacturer or Supplier shall securely attach tag

number and instructions for proper field handling and installation to each instrument.

PART 2 PRODUCTS

2.1 PCS – GENERAL PROVISIONS FOR PRODUCTS

A. General:

1. All electrically-powered equipment and devices shall be suitable for operation on 115-volt plus-or-minus 10 percent, 60 Hertz plus-or-minus two Hertz power. If different voltage or closer regulation is required, provide suitable regulator or transformer.

2. Provide appropriate power supplies for all two-wire transmitters, loops for monitoring discrete inputs and necessary outputs. Install power supplies mounted in enclosures, and install in appropriate control room or field panel.

3. Power supplies shall be suitable for a minimum of 130 percent of the maximum simultaneous current draw.

4. Provide power on-off switch or air circuit breaker for each item requiring electrical power.

5. Provide isolation transformers, line voltage regulators and power distribution panels for the distributed digital portions of the PCS to eliminate electrical noise and/or transients entering on the primary power line.

6. Unless otherwise shown or indicated in the Contract Documents, control system shall be furnished to use 4 to 20 mADC analog signals.

7. Provide signal converters and repeaters where required. Analog inputs to distributed control system shall be through appropriate repeaters to provide signal isolation where series-looped with other devices and to allow loop to maintain integrity even when distributed control system is out of service. Power supplies shall adequate for signal converter and repeater loads.

8. Signals shall be isolated from ground.

9. Signals shall not have a transient DC voltage exceeding 300 volts over one millisecond nor a DC component over 300 volts.

10. PCS and associated input/output wiring will be used in a facility environment where there can be high-energy AC fields, DC control pulses,

and varying ground potentials between the sensors/transducers or input contact locations and PCS components. PCS shall be adequate to provide proper protection against interferences from all such possible situations.

11. Instrumentation and PCS components shall be heavy-duty types, suitable for continuous service in a municipal wastewater treatment plant environment. Furnish products that are currently in production at the time products are shipped from the factory. All equipment furnished shall be of modular construction and be capable of field expansion through installation of plug-in circuit cards and additional cabinets as necessary. Logic and control loops shall be fail-safe.

12. Instrumentation and other PCS components shall return automatically to accurate measurement within 30 seconds upon restoration of power after a power failure, and when transferred to standby power supply.

13. Provide surge protection for instruments and all other PCS components that could be damaged by electrical surges.

14. Field-mounted instruments and PCS components shall be suitable for installation in humid and corrosive service conditions. Field-mounted instrument enclosures, junction boxes, and appurtenances shall comply with NEMA 4X requirements, unless otherwise shown or specified.

15. Relays with interconnections to field devices shall be wired through terminal blocks. Terminals as part of the relay base are unacceptable.

16. Panel mounted instruments, switches, and other devices shall be selected and arranged to present a pleasing coordinated appearance. Front-of-panel-mounted devices shall be of the same manufacturer and model line.

17. All components furnished, including field-mounted and rear-of-panel instruments, shall be tagged with the item number and nomenclature as shown and the instrument index in the Contract Documents or, as applicable, the "data sheets" that are part of the Contract Documents.

18. Ranges and scales specified in the Contract Documents shall be coordinated to suit equipment actually furnished. Range, scale, and set point values specified in other Sections of Division 13 are for initial setting and configuration. Coordinate specified values with actual equipment furnished to implement proper and stable process action as systems are placed in operation.

19. Field-mounted devices shall be treated with an anti-fungus spray.

20. Field-mounted devices shall be protected from exposure to freezing temperatures.

B. Environmental Conditions:

1. PCS and its components shall be designed and constructed for continuous operation under the following temperature and humidity conditions:

a. Equipment and Devices Installed in Control Rooms:

(1) Ambient Temperature: 60 degrees F to 80 degrees F normal range; and 40 degrees F to 105 degrees F occasional maximum extremes.

(2) Relative Humidity: 80 percent, normal; 95 percent maximum.

b. Equipment and devices installed at indoor locations (other than control rooms) for digital processing equipment hardware, control panels, and instruments:

(1) Ambient Temperature: 40 degrees F to 120 degrees F.

(2) Relative Humidity: 98 percent maximum.

c. Equipment and Devices Installed Outdoors:

(1) Ambient Temperature: -10 degrees F to 120 degrees F.

(2) Relative Humidity: 100 percent maximum.

C. Refer to Sections 13400 through 13491 for product requirements for materials and equipment that are part of the PCS.

PART 3 EXECUTION

3.1 PCS – GENERAL PROVISIONS FOR EXECUTION

A. Refer to Sections 13400 through 13491 for execution requirements for the PCS.

++ END OF SECTION ++

SECTION 13402

PROCESS CONTROL SYSTEM FACTORY TESTING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope

1. Contractor shall provide all labor, materials, equipment, and incidentals as specified and required for factory testing at the process control system manufacturer's facility to verify that system components function properly and comply with the functional and performance requirements of the Contract Documents.

    a. Coordinate with specification section 11610, Integrally Geared Single-Stage Centrifugal Blowers

    b. Coordinate with specification section 13306, Applications Engineering Services

2. Perform factory testing on the following types of equipment:

    a. Aeration Control Panel (ACP)

    b. Blower 1 Local Control Panel (BLW-LCP-1)

    c. Blower 2 Local Control Panel (BLW-LCP-2)

    d. Blower 3 Local Control Panel (BLW-LCP-3)

    e. Blower 4 Local Control Panel (BLW-LCP-4)

    f. Blower 5 Local Control Panel (BLW-LCP-5)

3. Contractor shall advise Engineer in writing of the scheduled dates for process control systems factory testing; submit such notice not less than 28 days prior to the scheduled start of factory testing. Owner and Engineer will be present at factory testing facility during operational testing of the process control systems at the factory, either for individual units or for the integrated system. Presence of Owner and Engineer during testing does not relieve Contractor from complying with the Contract Documents and shall does not indicate or imply acceptance of the equipment. When factory tests have been successfully completed, submit a factory test report to Engineer.

4. One Owner representative and one Engineer representative shall attend the witness testing. Expenses and costs for witnessing shall be paid by Contractor, including the following:

    a. Transportation of Owner and Engineer personnel to the factory test location and return via commercial airline, and ground transportation to and from airports as required.

    b. Overnight accommodations (two single occupancy rooms) in a hotel in reasonable proximity to the factory testing location. Room quality to be standard business class.

    c. Ground transportation between the hotel and factory testing location

    d. Meals for the duration of the testing. Meal allowance shall not be less than U.S. Internal Revenue Service guidelines.

B. Related Sections:

1. 11610, Integrally Geared Single-Stage Centrifugal Blowers

2. 13306, Applications Engineering Services

3. 13401, Process Control System General Provisions.

1.2 SUBMITTALS

A. Action Submittals: Submit the following:

1. Testing Plans:

    a. Submit factory test procedures in accordance with Section 13401, Process Control System General Provisions, for all equipment listed in Paragraph 1.1.A of this Section. Obtain Engineer's acceptance of testing plan not less than 28 days prior to scheduled start of factory test.

B. Informational Submittals: Submit the following:

1. Source Quality Control Submittals:

    a. Written results of factory testing for process control systems. Submit the complete factory test report within two weeks after completion of the factory test.

PART 2 – PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Inspections Prior to Factory Testing:

1. Inspect each panel, console, and cabinet to verify compliance with the Contract documents, and approved Shop Drawings and approved other Contractor submittals.

2. Inspection shall include, but not be limited to, the following:
   a. Nameplates and tags.

   b. Wire sizes and color coding.

   c. Terminal block contact ratings and numbers.

   d. Panel-mounted equipment and identification.

   e. External and internal panel layout.

   f. Proper wiring practices and grounding.

   g. Enclosure flatness, finish and color.

   h. NEMA rating and environmental control equipment.

3. Correct materials and equipment that do not comply with the Contract Documents and submittals approved by Engineer, and re-inspect until compliance is verified.

B. Factory Tests:

1. System Hardware Operational Testing:

   a. Test each input/output device and component to verify operability. If panel or device being tested contains pneumatic systems, test the instruments associated with such systems to verify that calibration.

   b. Test all system hardware components to verify proper operation of the equipment as stand-alone units and as a system. Tests shall include, but are not necessarily limited to, the following:

1) AC/DC power checks.

2) Power fail/restart tests.

3) Verify that quantity of circuits assigned to power field instruments corresponds to approved Shop Drawings and approved other Contractor submittals.

c. Criteria for Acceptance: System hardware operational testing shall acceptably demonstrate that specified and required equipment operations capabilities function properly.

d. Test remote I/O, operator interface terminals, Modbus or foundation Fieldbus linking devices, and similar devices, to verify that communication between units functions properly.

e. Perform an integrated system test, with all control system equipment connected (excluding field sensors and instruments), to verify that equipment performs and functions properly as an integrated system. During the factory test, simulate field sensors and instruments using appropriate signal generators, switches, and jumper cables.

2. System Hardware Demonstration (Programming by AESS)

a. Contractor shall perform and be solely responsible for system hardware demonstration factory test.

b. Preparation:

1) System performance shall be tested using fully-integrated system, including all software and hardware. Entire control system, including one of each type of field device with interconnecting cables, shall be assembled at the factory test location and simulated inputs applied. Signal generators shall be appropriately sized and calibrated for full range of use and shall have a power source to accommodate not less than a full day of testing. Prior to the factory test, provide process I/O simulation panel that includes the following:

a) Toggle switches to simulate field or other input contacts.

b) Indicating lights to simulate outputs from tested panels.

c) Control relays to simulate motor control center coil inputs.

d) Time relays to simulate position switches.

e) Indications (in milliamps) to indicate every 4 to 20 ma-dc output from tested panel.

f) Potentiometers to simulate 4 to 20 ma-dc inputs to tested panel.

g) Each device shall have nameplate with description and device's process and instrumentation Drawings (P&ID) tag number. Nameplates shall be removable and interchangeable for multiple use of the panel during the test.

2) Operator Interfaces: Prior to factory testing of the system, configure the display environments in accordance with the display structure agreed upon by Contractor, Engineer, and Owner, and load and link database parameters to the specified fields.

c. Factory Test:

1) Contractor shall demonstrate system software utility programs and system software security programs incorporated into the control system, to demonstrate proper functioning of the various functions and capabilities specified.

2) Perform complete system test, during which entire system shall operate continuously without failure in accordance with the Contract Documents.

3) Demonstrate the monitoring and control information displayed on each HMI screen, based on simulation of each associated point for each screen, in accordance with test procedure approved by Engineer. Simulation through forced values in the PLC programming is acceptable. In addition, Owner or Engineer will randomly select, at the time of the factory test, additional inputs and outputs to be simulated in quantity not less than five percent of total I/O quantity. Demonstrate that monitoring and control application software associated with I/O points performs and functions as intended.

4) Demonstrate communications between integrated system elements; include such demonstration in the testing procedure submittal, where applicable.

5) Operator Interfaces:

a) During factory test, demonstrate overall display structure, including environment configurations, passwords, security, and other parameters and functions.

b) Review menu display contents to demonstrate how an operations person will navigate within the overall display structure.

c) Demonstrate assignment of displays to annunciator keys.

d) Review each graphic display for correctness relative to layout, symbols, color scheme, and other requirements.

e) Demonstrate operation of standard alarm management displays (current alarm display, alarm history, and similar alarm displays).

f) Perform demonstration of each type of report specified. Printing shall be an integral part of the report demonstration.

3. Factory Test Acceptance Criteria:

a. In addition to complying with Paragraph 2.1.B.1 of this Section, failure or non-functioning of one or more communication links, failure of more than five percent of the total control functions, more than ten internal panel wiring discrepancies including I/O point cross-wirings, or more than ten I/O point- or database-addressing errors will be unacceptable and constitutes factory test failure.

b. Do not ship the equipment from the factory until Engineer accepts the factory test results submittal.

c. Modifications, if any, to documentation as a result of the factory tests shall be completed before shipping the control system.

d. Should a factory test run fail to comply with the Contract Documents, necessary changes and corrections shall be made and the entire system retested until acceptable results are achieved.

e. Expenses and costs for Owner and Engineer witnessing such retesting shall be paid by Contractor, in accordance with paragraph 1.1.A.4 above.

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 13403

PROCESS CONTROL SYSTEM
START-UP AND FIELD TESTING

PART 1 - GENERAL

1.1 SYSTEM CHECK-OUT AND START-UP RESPONSIBILITIES

A. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all equipment and coordinate all activities necessary to perform check-out and start-up of the equipment.

B. Contractor shall retain the services of the Instrumentation and Controls (I&C) Supplier and Applications Engineering Services Supplier (AESS) to supervise and/or perform check-out and start-up of all system components. As part of these services, the system Supplier shall include for those equipment items not manufactured by him the services of an authorized manufacturers' representative to check the equipment installation and place the equipment in operation. The manufacturers' representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.

1.2 SYSTEM CHECKOUT AND START-UP

A. Contractor, under the supervision of the I&C Supplier and AESS, and other instrument suppliers as applicable, shall perform the following:

1. Check and approve the installation of all PCS components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.

2. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in this Work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.

B. Contractor shall provide all test equipment necessary to perform the testing during system checkout and start-up.

C. Contractor and Supplier shall be responsible for initial operation of monitoring and control system and shall make any required changes, adjustment or replacements for operation, monitoring and control of the various processes and equipment necessary to perform the functions intended.

D. Contractor shall furnish to the Engineer certified calibration reports for field instruments and devices specified in Section 13420, Primary Sensors and Field Instruments, and panel mounted devices specified in Section 13440, Panel-Mounted Instruments and Devices, as soon as calibration is completed.

E. Contractor shall furnish to the Engineer an installation inspection report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both Contractor and the Supplier.

1.3 INTEGRATED SYSTEM FIELD TEST

A. Following the PCS checkout and initial operation, Contractor, under the supervision of the Supplier, shall perform a complete system test to verify that all equipment and programmed software is operating properly as a fully integrated system, and that the intended monitoring and control functions are fully implemented and operational. Any defects or problems found during the test shall be corrected by Contractor and then retested to demonstrate proper operation.

B. Following demonstration of all system functions, the PCS including field sensors/transducers and instruments shall be running and fully operational for a continuous 48 hour period. The Operational Availability Demonstration specified below shall not begin until the continuous 48 hour integrated system test has been successfully completed and Owner and Engineer agree that the Operation Availability Demonstration can begin.

1.4 OPERATIONAL AVAILABILITY DEMONSTRATION

A. Operational Availability Demonstration (OAD) shall begin following completion of the integrated system field test as specified above and shall continue until a time frame has been achieved wherein the system (both hardware and software) availability meets or exceeds 99.7 percent for 60 consecutive days and no system failures have occurred which result in starting the OAD over again. During the OAD the system shall be available to plant operating personnel for use in normal operation of the plant.

B. For the purpose of the OAD, the system will be defined as consisting of the following systems and components:

1. Bay Park Aeration Tank System

C. The conditions listed below shall constitute system failures which are considered critical to the operability and maintainability of the system. The OAD shall be

terminated if one or more of these conditions occur. Following correction of the problem, a new 60 consecutive day OAD shall begin.

1. Failure to repair a hardware or software problem within 120 consecutive hours from the time of notification of a system failure.

2. Recurrent hardware or software problems: if the same type of problem occurs three times or more.

3. Software problem causing a processor to halt execution.

D. The following conditions shall constitute a system failure in determining the system availability based on the equation specified in Paragraph 1.4.E., below:

1. Failure of an isolation damper or Fan.

2. Loss of communications between devices on the communications network.

3. Failure of one or more input/output components.

4. Failures of any type affecting ten or more input/output points simultaneously.

5. Failure of any type affecting one or more regulatory control loops or sequential control strategies thereby causing a loss of the automatic control of the process variable or process sequence operation.

6. Failure of power supply. Where redundant power supplies are provided, failure of one power supply shall not constitute a system failure provided the backup power supply operates properly and maintains supply power. Failure of the backup supply to operate properly and maintain supply power shall constitute a system failure.

7. Failure of three or more primary sensors/transducers or field instruments simultaneously.

E. The system availability shall be calculated based on the following equation:

$$A = \frac{TTO}{TTO + TTR} \times 100 \text{ percent}$$

where, A = system availability in percent

TTO = total time in operation
TTR = total time to repair

E. Time to repair shall be the period between the time that Contractor is notified of a system failure and the time that the system has been restored to proper operation in terms of hours with an allowance for the following dead times which shall not be counted as part of the time to repair period.

1. Actual travel time for service personnel to get to the Site up to six hours per incident from the time Contractor is notified of a system failure.

2. Time for receipt of spare parts to the plant site once requested up to 24 hours per incident. No work shall be done on the system while waiting for delivery of spare parts.

3. Dead time shall not be counted as part of the system available period. The dead time shall be logged and the duration of the OAD extended for an amount of time equal to the total dead time.

G. Completion of a 60 consecutive day period without any restarts of the OAD and with a system availability in excess of 99.7 percent will constitute acceptance of the PCS by Owner.

H. All parts and maintenance materials required to repair the system prior to completion of the OAD shall be supplied by Contractor at no additional cost to Owner. If parts are obtained from the required plant spare parts inventory, they shall be replaced to provide a full complement of parts as specified.

I. A Plant Monitoring and Control System Malfunction/Repair Reporting Form shall be completed by the plant personnel and Engineer to document system failures, to record Contractor notification, arrival and repair times and Contractor repair actions. Format of the form shall be developed and agreed upon prior to the start of the OAD.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 13404

PROCESS CONTROL SYSTEM
TRAINING

PART 1 - GENERAL

1.1 REQUIREMENTS AND RESPONSIBILITIES

A. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to perform and coordinate all required training at times acceptable to Owner and Engineer.

B. Contractor shall retain the services of the Supplier and Applications Engineering Services Supplier (AESS) to provide operation and maintenance training for all PCS equipment as specified herein.

C. For equipment items not manufactured by the Supplier, the Supplier shall provide for on-site training by an authorized representative of the equipment manufacturer as part of the Supplier's services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.

D. Contractor shall be responsible for all costs, including cost of travel, meals and lodging, if required, associated with training, both on-site and at the suppliers facilities, and shall provide all required materials, texts and required supplies. Engineer approval of quantity and type of material occurs during the submittal process and is described in Paragraph 1.2.A below.

E. All training shall be conducted in the normal eight-hour working days until conclusion of the training course. For training at the Supplier's facility, the course instructor shall be assigned full time and shall not perform other duties throughout the period of the course.

1.2 SUBMITTALS

A. Within 90 days of the effective date of the Notice to Proceed, Contractor shall submit his plan for training to the Owner and Engineer. Included in the plan shall be course outlines and schedules for training to be provided at the Supplier's facilities.

1.3 ON-SITE TRAINING

A. Primary Sensors/Transducers and Field Instruments:

1. Provide on-site operation and maintenance training by Supplier and the equipment manufacturer representatives prior to placing the equipment in continuous operation. The services of equipment manufacturer's representatives shall be provided for a minimum of eight hours for each type of instrument provided.

2. Training shall accomplish the following:
   a. Provide instruction covering use and operation of the equipment to perform the intended functions.

   b. Provide instruction covering procedures for routine, preventive and troubleshooting maintenance including equipment calibration.

   c. Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall plant monitoring and control system.

B. Training covering the control equipment as shown on I&C contract drawings:

1. The I&C Supplier and AESS shall provide 3 days of operations training covering all system components.

2. Training course shall accomplish the following:

   a. Provide all instructions necessary to operate and utilize all system components.

   b. Provide all instruction necessary to monitor and control the system processes from the designated control panel.

   c. Explain procedures for control of the system during scheduled or rescheduled shutdown and the subsequent start-up.

   d. Provide instructions for regular caretaking operations.

C. PLC Training:

1. The I&C Supplier and AESS shall provide 3 days of training that covers PLC related topics as follows:

   a. Provide an overview of system hardware and software.

   b. It shall train people in configuration, operation and programming processors.

c. The emphasis shall be placed on how to perform set point changes, minor programming changes, range changes, diagnostics and upkeep of documentation.

d. Instruction for hardware and software maintenance, trouble shooting and maintenance planning.

D. Training following two months of regular system operations:

1. The I&C Supplier shall provide operation and maintenance covering all system equipment provided.

2. The training shall be of the same format, content and duration as the training described in Paragraph 1.3.A. and Paragraph 1.3.B., above.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++

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SECTION 13420

PRIMARY SENSORS AND FIELD INSTRUMENTS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation all primary sensors and field instruments shown and specified herein.

2. Contract Documents illustrate and specify functional and general construction requirements of the sensors and field instruments and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. Contractor shall provide all components, piping, wiring, accessories and labor required for a complete, workable, and integrated system.

3. Contractor shall be responsible for installing in-line flow elements (magnetic flow meter flow tubes, insert flow tubes, propeller flow meters) and for providing taps in the process piping systems for installation of other flow, pressure, and temperature sensing instrumentation.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all components and systems.

C. Related Sections:

1. Section 05051, Anchor Systems

2. Section 13401, Process Control System General Provisions

3. Section 13403, Process Control System Startup and Field Testing.

4. Section 13404, Process Control System Training.

5. Section 13440, Panel Mounted Instruments and Devices

6. Section 15052, Exposed Piping Installation.

7. Section 15061, Ductile Iron Pipe.

1.2 QUALITY ASSURANCE

A. Comply with the requirements of Section 13401, Process Control System General Provisions.

B. Acceptable Manufacturers:

1. Furnish primary sensors and field instruments by the named manufacturers or equal equipment by other manufacturers.

2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.

3. Obtain all sensors and field instruments of a given type from the same manufacturer.

C. Responsibilities and Services:

1. Provide primary sensors and field instruments in accordance with the applicable general design requirements specified in Section 13401, Process Control System General Provisions, and the detailed Specifications herein.

2. Field supervision, inspection, start-up and training in accordance with the requirements of Section 13403, Startup and Field Testing, and Section 13404, Training.

1.3 DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 13401, Process Control System General Provisions.

B. Primary sensors and field instruments shall not be delivered to the Site until all product information and system Shop Drawings for the sensors and instruments have been approved by the Engineer.

1.4 SUBMITTALS

A. Comply with the requirements of Section 13401, Process Control System General Provisions.

1.5 MATERIALS OF CONSTRUCTION FOR WETTABLE PARTS

A. Provide compatible materials of construction for primary sensors and field instrument (wetted) parts that come in contact with the process fluids.

1.6 IDENTIFICATION TAGS

A. Tagging Requirements:

1. Tag numbers of sensors and field instruments shall be as shown and as specified. For items not shown or specifically tagged, the item tag number shall be established by the system supplier. All instruments, whether field or panel mounted, shall have an identification tag.

2. Information to be permanently engraved onto the tag shall include the identifying tag number, manufacturer, model number, service, and range.

3. Identifying tap number shall be permanently etched or embossed onto a stainless steel tag which shall be fastened to the device with self-tapping stainless steel screws. Where fastening with screws cannot be accomplished the tags shall be permanently attached to the device by a circlet of stranded stainless steel wire rope and clamp.

4. All sensors and field instruments mounted on or within control panels and enclosures shall have the identification tag installed so that the engravings are easily visible to service personnel. Devices mounted on the face of panels shall have the tags attached to the rear of the devices.

PART 2 PRODUCTS

2.1 GENERAL DESIGN REQUIREMENTS

A. Power Supplies:

1. All electrically powered equipment and devices shall be suitable for operation on 115 volt, ±10 percent, 60 Hz, ± 2 Hz power. If a different voltage or closer regulation is required, a suitable regulator or transformer shall be provided at no additional cost to the Owner.

2. Appropriate power supplies shall be furnished by Contractor for any field instrument requiring a power source less than 115 volts. Power supplies shall be mounted in control panels or enclosures installed near the instruments or in field panels.

3. Design all power supplies for a minimum of 130 percent of the maximum simultaneous current draw.

B. Miscellaneous:

1. All instrumentation components shall be heavy-duty types, designed for continuous service. The system shall contain products of a single manufacturer, when possible, and consist of equipment models which are

currently in production.

2. All field-mounted instruments and system components shall be designed for installation in humid and corrosive service conditions. All field mounted instrument enclosures, junction boxes and appurtenances shall conform to the NEMA ratings that meet hazardous rating requirements shown on Contract Drawings and on the Instrument Data Sheets.

3. The named manufacturers have been specified to establish the standard of quality and performance of equipment to be supplied.

2.2 PROCESS TAPS, SENSING LINES AND ACCESSORIES

A. Air Pressure Sensing Lines and Accessories for Air Flow/Pressure Transmitters:

1. Material: Type 316 stainless steel tubing, ASTM A269, medium wall thickness.

2. Pressure Rating: 150 psi.

3. Size: 1/2-inch O.D. for air.

4. Connections: Type 316 stainless steel compression type, "Swagelok" by Crawford, or equal.

5. Shut-off Valves:

a. Type: Ball.

b. Pressure Rating: 150 psi.

c. Body, Ball and Stem: Type 316 stainless steel.

d. Packing: High density TFE.

e. Handle: Nylon with metal travel stops.

f. Support Rings: TFE coated Type 316 stainless steel.

g. End Connections: Removable "Swagelok", or equal.

h. Products and Manufacturers: Provide one of the following:

(1) 43 Series, as manufactured by Whitey.

(2) Or equal.

6. Manifolds:

a. Type: 2-valve and 5-valve meter manifolds.

b. Materials: Type 316 stainless steel body, bonnets and stems; delrin seats; teflon packing.

c. Products and Manufacturers: Provide one of the following:

(1) Anderson-Greenwood.

(2) Or equal.

B. Pressure Tap Sensing Lines and Accessories for Pressure Gauges and Pressure Switches:

1. For Process Sensing Taps in Ductile Iron, Steel and Stainless Steel Piping Systems:

a. Material and Fittings: Type 304 stainless steel pipe (ASTM A 312) and threaded fittings and adapters (ASTM A 403).

b. Sizes: 1/2-inch minimum for main sensing piping and 1/2-inch gauge and switch connections.

c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the Exposed Piping Schedule in Section 15052, Exposed Piping Installation.

d. Accessories:

(1) For applications not requiring diaphragm seals, provide separate 1/2-inch Type 316 stainless steel threaded ball valve for each gauge and switch.

(2) For applications requiring diaphragm seals, provide a separate 1/2-inch threaded Type 316 stainless steel ball valve for seal process side shutoff.

e. For Process Sensing Taps in Copper and Thermoplastic Piping Systems:

f. Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system.

g. Sizes: 1/2-inch minimum for main process sensing piping and 1/2-inch for gauge and switch connections.

h. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in Section 15052, Exposed Piping Installation.

i. Accessories:

(1) For copper piping system taps with or without seals, provide a separate 1/2-inch minimum threaded brass or bronze ball valve for each gauge and switch.

(2) For PVC piping systems with or without diaphragm seals, provide a separate 1/2-inch threaded ball valve for process sensing line shutoff.

2.3 PRIMARY SENSORS AND FIELD INSTRUMENTS

A. General:

1. All primary sensors and field instruments specified in this Section shall conform to the requirements of the Instrument List provided after PART 3 of these specifications.

2. All primary sensors and field instruments provided under other Sections shall comply with the requirements of this Section.

3. The named manufacturers have been specified to establish the standard of quality and performance of equipment to be supplied.

4. Instruments and devices shall not be assembled in the panels until all product information and system shop drawings for respective components have been approved.

B. DISSOLVED OXYGEN MEASUREMENT SYSTEM

1. Designed for continuous monitoring of dissolved oxygen concentration for the following services:

a. Aeration tanks mixed liquor

b. The system shall consist of:

(1) Immersion-type sensor

(2) Manufacturer-supplied cabling between sensor and transmitter

(3) Transmitter

c. Sensor and transmitter mounting hardware

d. System Accuracy:

(1) Below 5 ppm: Plus or minus 0.1 ppm

(2) Above 5 ppm: Plus or minus 0.2 ppm

2. System Repeatability: Plus or minus 0.1 ppm

3. Sensor

a. Technology: Luminescence or fluorescence

b. Operating Temperature Range: 32 – 122 degrees F

c. Flow Rate: None required

d. Measurement Range: 0 – 20 ppm

e. Response Time: 40 seconds or less for 90 percent of value

f. Materials of Construction: Corrosion-resistant

4. Sensor Cable: Length sufficient for the installation as shown

5. Transmitter

a. Display: Digital display of dissolved oxygen concentration and fluid temperature

b. Analog Outputs:

(1) Type: 4 – 20 mAdc with HART

(2) Quantity: At least two

(3) Maximum Load: 500 ohms or higher

c. Relay Outputs:

(1) Type: SPDT

(2) Quantity: At least two

(3) Rating: At least 2A at 120 VAC

6. Power: 120 VAC

7. Ambient Conditions: 0 to 140 degrees F

8. Enclosure: NEMA 4X

9. Sensor/Transmitter Mounting

    a. Refer to mounting detail on Contract Drawings. Ensure mounting is in accordance with the manufacturer's recommendations.

    b. Sensor shall be mounted to a stainless steel instrument stand; provide all required mounting hardware. The mounting arrangement shall permit easy extraction from the tank for cleaning, inspection, and maintenance without disconnecting wiring or tubing. When extracted, the sensor and support pipe shall be horizontal; provide support for the extracted sensor and support pipe.

    c. The sensor mounting arrangement shall be airtight while the probe is in operation.

    d. Transmitter shall be mounted to a stainless steel instrument stand; provide all required mounting hardware, including a transmitter weather/sun shield.

10. Products and Manufacturers: Provide one of the following:

    a. Hach LDO sc Probe Model 2 sensor and Model sc4500 transmitter

    b. Or approved equal

    c. Endress+Hauser shall not be considered

C. COMBINATION AMMONIUM / NITRATE ANALYZER

1. AN-ISE sc Ammonium (Ammonium value will be converted to Ammonia) and Nitrate Combination Sensor

    a. Function and Performance:

        (1) Measurement range ammonium: 0.2 to 1000 mg/L-N

        (2) The ammonium value will be converted to Ammonia by using the following equation NH4 X 0.9441 (derived by dividing the molecular weight of NH3 by NH4) ≈ NH3.

(3) The analyzer will read out in ammonium, conversion must be performed by end user

(a) The ammonium value will be converted to N by using the following equation: NH4 X 0.7778 (derived by dividing the molecular weight of N by NH4) ≈ N.

(4) Measurement range nitrate: 0.2 to 1000 mg/L-N

(a) The analyzer will read out in nitrate, conversion must be performed by end user

(b) The nitrate value will be converted to N by using the following equation: NO3 X 0.2258 (derived by dividing the molecular wight of N by NO3) ≈ N.

(5) Accuracy: 5% of measured value ±0.2 mg/L (with standard solutions)

(6) Detection limit: 0.2 mg/L

(7) Response time: less than 3 minutes

(8) When connected to a multi-parameter digital controller the overall status of the instrument performance is displayed as a percentage value via a measurement indicator

(9) When connected to a multi-parameter digital controller the overall time remaining until maintenance tasks are due is displayed in days

b. Physical:

(1) Sensor/Transmitter Mounting

(2) Refer to mounting detail on Contract Drawings. Ensure mounting is in accordance with the manufacturer's recommendations.

(3) Sensor shall be mounted to a stainless steel instrument stand; provide all required mounting hardware. The mounting arrangement shall permit easy extraction from the tank for cleaning, inspection, and maintenance without disconnecting wiring or tubing. When extracted, the sensor and support pipe shall be horizontal; provide support for the extracted sensor and support pipe. The sensor mounting arrangement shall be airtight while the probe is in operation.

(4) Transmitter shall be mounted to a stainless steel instrument stand; provide all required mounting hardware, including a transmitter weather/sun shield.

(5) Power Requirements: 120 VAC/60 Hz.

(6) Enclosure Rating: NEMA 4X

(7) Display: Menu-driven LCD display with numerical or graphical results.

c. Accessories Required:

(1) One year's supply of consumables.

(2) Mounting bracket as shown in the Drawings.

(3) Cleaning Unit

(4) Sufficient cable for installation between the sensor and analyzer/controller as indicated on the Contract Drawings.

d. Manufacturer(s):

(1) Hach AN-ISE sc Combination Ammonium and Nitrate sensor

(2) Or approved equal

(3) Endress+Hauser shall not be considered

2. Analyzer/Controller

a. Type: Microprocessor-based controller compatible with sensor furnished.

b. Function/Performance:

(1) Accuracy: plus or minus 0.1 percent of span.

(2) Repeatability: plus or minus 0.05 percent of span.

(3) Response Time: 60 seconds to 90 percent of value on step change.

(4) Temperature Range: -40 to 60 degrees C.

(5) Input: Controller shall be capable of accepting at least two

sensor inputs.

(6) Output: Two 4-20 mA outputs and four programmable Form C alarm contact outputs rated for 5A at 230 VAC.

(7) Temperature Compensation: Compensation over the temperature range of the instrument.

(8) Diagnostics: On screen instructions and display of self-diagnostics.

(9) Display: Digital indicator displaying concentration in ppm and temperature of the medium.

c. Physical:

(1) Converter shall be suitable for surface or pipe stand mounting.

(2) Enclosure shall be NEMA 4X (IP67).

(3) Power requirements: 120 VAC/60 Hz.

(4) Sunshade shall be provided to protect display from UV Damage.

d. Manufacturer(s):

(1) Hach sc4500 Controller.

(2) Or approved equal.

(3) Endress+Hauser shall not be considered.

D. PRESSURE AND DIFFERENTIAL PRESSURE TRANSMITTERS

1. Transmitters shall be microprocessor based "smart" electronics, two-wire, loop powered (24VDC) and HART compatible devices. Differential pressure transmitters used for flow measurement shall include integral square root extraction function.

2. For transmitters for use in Venturi meter temperature compensation, transmitters shall have multivariable capabilities. RTDs shall be as specified in this section.

3. Accuracy: +\- 0.10 percent of calibrated span. Response time shall be less than one (1) second.

4. Load resistance: 1000 ohms; Turndown Capability: Minimum of 50:1.

5. Span and zero continuously adjustable, either locally or via hand-held digital interface.

6. Transmitter housing and diaphragm materials shall be as follows:

    a. Body and Process Connection Bolting: Type 316 SS

    b. Housing and Cover: Die cast low copper aluminum alloy finished with epoxy paint system; cover shall be threaded and seated on Buna-N O-rings

    c. Process Wetter parts: 316 SS

    d. NEMA 4X rating

7. Integral 4-digit LCD output indicator graduated 0-100 percent.

8. 1/2-inch NPT process connections.

9. Furnish transmitter with 2-valve manifold (absolute/gauge pressure) or 5-valve manifold (differential pressure). Transmitter and manifold shall be furnished as one, fully tested complete assembly.

10. Area Classification: As specified in Appendix A – Instrument List.

11. Products and Manufacturers: Provide one of the following:

    a. Rosemount 3051 series

    b. Or equal

E. DIAPHRAGM SEALS

1. General: Furnish diaphragm seals for pressure gauges, switches and transmitters at locations shown and as specified.

2. Required Features

    a. Provide fill/bleed screw to permit filling of instrument and diaphragm seal.

    b. Instrument Connection: ½" NPT.

    c. Process Connection: 1" NPT.

    d. Working Pressure Rating: Equal to or greater than the attached

gauge or switch operating pressure specified.

e. Bolting Materials: Type 316SS for non-wetted exposed parts (typ.)

f. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.

g. Flushing connection: ½" NPT.

3. Construction Features

a. Top Housing: Type 316 stainless steel.

b. Diaphragms: 316SS

c. O-Ring: Buna-N

d. Gasket: PTFE

e. Process Side Housing Material: 316 SS for metallic piping; CPVC to match non-metallic piping.

f. Sensing Liquid: Use silicone except for process fluids containing chlorine. When the process fluid contains chlorine, provide Halocarbon 63 or Flurolube 63 for the filling liquid.

g. Working Pressure Rating: Equal to or greater than the attached instrument, and the operating pressure specified in the Exposed Piping Installation, section 15109, whichever is greater.

4. Assembly and Calibration

a. Provide complete diaphragm seal assembly, including gauge, switch or transmitter, shall be factory assembled, filled and calibrated to the ranges and switch setpoints specified prior to shipment.

b. Coordinate location and orientation of the gauges, switches and seal assemblies with the actual piping and equipment installations so that gauges and indicators can be easily read and accessed for maintenance by OWNER personnel.

c. Where field mounting and orientation conflicts arise due to incomplete coordination with field changes in the process piping

and equipment installation, relocate, re-orient, re-assemble, and re-calibrate as directed by the ENGINEER at no cost to the OWNER.

5. Product and Manufacturer

   a. Type 741, as manufactured by Ashcroft.

   b. As Option with Instrument.

   c. Or approved equal.

F. PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

1. Type: Dial-indicating bourdon tube

2. Performance Requirements:

   a. Normal Operating Pressure Range: As specified in Appendix A – Instrument List or as required by process.

   b. Accuracy: ± 5 percent of maximum scale reading.

   c. Ambient Temperature Limits: -40°F to 140°F.

3. Gauge Scale

   a. For applications with constant, steady pressure: Provide pressure and differential pressure gauges with a full scale range that is approximately twice the normal operating pressure. The measured pressure shall not exceed two-thirds of the full scale range of the gauge.

   b. For applications with fluctuating pressure: Provide gauges that have a full scale range of approximately twice the average measured pressure. The maximum of the measured range shall be nor more than two-thirds of the full scale range of the gauge.

4. Construction Features

   a. PVC body with 316 stainless steel diaphragm

   b. Pulsation dampening and vibration dampening for the gauge pointer for gauge readability using an engineered dampening media (EDM)

   c. Stainless steel movements

d. Case Material: Black Phenolic, solid type, hermetically sealed (NEMA 4X)

e. Aluminum gauge dial, nominal size of 4-1/2 inch. Linear scale, white face with black numerals and markings

f. Process Connection: Bottom, 1/2-inch NPT with 316 SS male fitting extending a minimum of 1-1/4 inches beyond the case

g. External Mounting Lugs

5. Provide pressure gauges as follows:

a. Duragauge, as manufactured by Ashcroft (Gauge Pressure)

b. Type 5503, as manufactured by Ashcroft (Differential Pressure)

c. Or approved equal

G. PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

1. Type: Switch assembly with diaphragm/piston pressure sensor.

2. Function: Sense gauge, absolute or differential pressure and open or close a contact when the pressure reaches the specified trip point.

3. Performance Requirements:

a. Operating Range: As specified in Appendix A – Instrument List or as required by process.

b. Setpoint: As specified in Appendix A – Instrument List.

c. Setpoint Repeatability: ± 1 percent of range.

d. Accuracy: ± 2 percent of range.

e. Output: Snap action switch, with SPDT contacts rated not less than 5 amp resistive at 120 VAC and 1/2 amp resistive at 24 VDC.

f. Switch and Reset Action: Adjustable Deadband.

g. Adjustable Deadband Range and Setting: maximum full scale, minimum 10% of scale.

h. Ambient Temperature Limits: -40°F to 140°F.

4. Construction Features

a. Switch Housing and Diaphragm Materials:

(1) Body and Process Connection Bolting: Type 316 stainless steel.

(2) Housing and Cover: Die cast low copper aluminum alloy finished with epoxy paint system; provide covers threaded and seated on Buna-N O-rings; NEMA 4X rating

b. Process Wetted Parts

(1) 316 stainless steel

(2) For switches used with diaphragm seals, process wetted parts shall be Buna-N.

(3) Water Service with Copper Pipe: Brass housing with Buna-N diaphragm.

(4) Other Services: 316 stainless steel.

c. Set and Reset Point Adjustments: Provide switches with setpoints and deadbands that are adjustable using adjusting nuts and pressure setting scales in psi units. Switches shall be field adjustable.

d. Process Connection: 1/2-inch NPT.

e. Housing: Copper-free die cast aluminum.

f. External Mounting Lugs.

g. Electrical Connection: 1/2-inch NPT.

h. Area Classification: As specified in Appendix A – Instrument List

5. For clean service applications, furnish pressure switches with 2-valve manifold (absolute/gauge pressure) or 5-valve manifold (differential pressure). Switch and manifold shall be furnished as one, fully tested complete assembly.

6. Products and Manufacturers: Provide one of the following:

a. Ashcroft G-Series

b. Or approved equal

H. TEMPERATURE SENSORS

1. RTD

a. Materials:

(1) Sensor: Platinum

b. Sheath Materials:

(1) 900 DEGF maximum: Type 316 stainless steel.

(2) 1200 DEGF maximum: Inconel.

(3) Insulation: Ceramic or metallic oxide.

c. Design and fabrication:

(1) 100 ohms at 0 DEGC.

(2) Spring loaded.

(3) Dual element.

(4) Lead wire compensation: Three- or four-wire.

(a) Lead wire length shall be specified such that there is sufficient length to reach the transmitter.

(5) Accuracy: +0.5 DEGF or +0.5 PCT of measured temperature, whichever is greater.

(6) Sheath: Type 316 Stainless Steel

(7) Sheath diameter: 1/4 IN.

(8) Insertion Length: Provide RTDs with sufficient insertion length ("U" dimension) to eliminate conduction error and optimize temperature element response time. RTDs insertion length shall be selected such that the immersion length of the RTD is 1/3 to 2/3 of the internal pipe diameter. The RTD length shall be coordinated with the length of the associated thermowell.

d. Product and Manufacturer:

(1) Rosemount

(2) Or Approved Equal

2. Thermowells

a. Materials:

(1) Well: ASTM A182, F316 stainless steel.

(2) Head: Cast iron.

b. Design and fabrication:

(1) Constructed in accordance with ASME PTC 19.3 TW.

(2) Lagging extension sufficient to provide wrench clearance above lagging.

(3) Seal welded on applications where process pressure exceeds 450 PSI.

(4) Test thermowells shall be supplied with watertight cap and chain.

c. Temperature Transmitters

(1) Enclosure Materials: Aluminum

(2) Design and fabrication:

1) Smart transmitter utilizing microprocessor based electronics.

2) Input: RTD.

3) Transmitter inaccuracy shall be in accordance with the following:

(b) 100 ohm platinum RTD input: +/-0.25 DEGF +0.02 PCT of span or +/-0.2 DEGF +0.025 PCT of span or +/-0.09 DEGF +0.05 PCT of span, whichever is greater.

(3) Stability: Any of the following drift limits are acceptable:

1) Greater of: 0.1 PCT of reading or 0.1 DEGC per 12 months.

2) 0.05 PCT of input reading plus 0.043 PCT of span per 12 months.

3) 0.05 PCT of maximum span per 12 months.

(4) Ambient temperature effects (including digital, D/A conversion, and cold junction effects):

(a) Any of the following effects per 50 DEGF change are acceptable:

d. One-half reference inaccuracy plus 0.18 DEGF.

e. Effects in accordance with the following inputs: 100 platinum RTD input: +/-0.08 DEGC +0.025 PCT of (reading +200) +0.025 PCT of span +0.02 PCT of (reading - lower range value).

f. Ambient temperature limits:

(1) -40 to 185 DEGF.

(2) Integral LCD meter: -4 to 158 DEGF.

g. Output: 4-20 mA DC signal linearly proportional to temperature.

h. Power supply: 24 VDC loop powered.

i. Adjustable span.

j. Adjustable zero.

k. Products and Manufacturer:

(1) Rosemount

(2) Or Approved Equal

I. LEVEL SWITCHES – FLOAT TYPE

1. Materials:

a. Float material: Polypropylene or Teflon coated type 316 stainless steel.

b. Cable jacket: PVC, neoprene.

c. Cable clamp: Polypropylene or 316 stainless steel.

2. Design and fabrication:

a. Mercury-free switch.

b. Provide switch complete with flexible electrical cables.

c. DPST contact rated at 1 amp at 120 VAC.

d. Direct acting float switch:

3. Switch actuates on rising level.

4. Switch deactivates when liquid falls 1 IN below actuation level.

a. Terminate cables in junction box.

b. Process temperature: max. 120 DEGF.

c. Install floats per drawing details.

5. Products:

a. GEMS LS-750 Series

b. Or Approved Equal

J. VENTURI FLOW METERS

1. General: The metering primary element shall be of the pressure differential producing type utilizing pure static pressure sensed at the inlet and throat sections.

a. Performance: The Venturi flow meter shall have an accuracy of +/- 0.5% of actual flow above a pipe Reynolds number of 75,000 with a constant discharge coefficient of 0.9900 which shall be independent of line size and Beta ratio.

b. Validation of Performance: The manufacturer shall provide data substantiating that the Venturi accuracy is based upon independent flow laboratory test data of hydraulically similar devices. Accuracy of the meter shall be within a range of plus 0.50 percent and minus 0.50 percent of the actual flow rate, at all points above 10 percent of maximum flow, with a 95 percent confidence level. This accuracy shall be substantiated by a two times standard deviation calculation of at least 30 calibrated meter coefficients of different line size and beta ratio meters as described in the ASME Fluid Meters, 6th edition. Test data shall include at least a 15:1 line size range for laboratory calibrated 4-inch to 72-inch Venturi meters, 2:1 beta ratio range, 75,000 to 3,200,000 Reynolds number range, and venturi meter discharge coefficient substantiation to confirm the proposed Venturi meter is in full compliance with the specifications herein. A certified report confirming compliance with these requirements shall be submitted along with

manufacturer's proposal. Failure to comply with this requirement shall be grounds for rejection.

c. Tube Design: The Venturi meter shall have a cylindrical inlet section of the same inside diameter as the inlet piping and shall contain two high pressure taps and a single vent and drain tap. The cylindrical throat section shall contain two low-pressure taps. The length of the cylindrical throat section shall be equal to one-half its diameter. The converging section shall be comprised of a single angle of 30 degrees. Converging sections using a radius shall not be acceptable. The recovery section shall be comprised of an inclusive angle of 10 degrees and shall be truncated at approximately 90% of the downstream pipe inside diameter. The Venturi shall be provided AWWA C207 Class B flanged ends unless otherwise specified. Proprietary flow tubes that do not sense true static inlet and throat pressure, or which employ entire or partial pitot effects to amplify differential or introduce noise shall not be accepted.

d. Fabrication Qualifications: The Venturi meter supplier shall submit a complete manufacturing plan to include calculations for proper material thickness which will be used for all meters. A full Q/A procedure shall be provided and shall include welders qualifications, material and weld testing procedures, and proof of welders current certification for all procedures that will be used in the manufacturing of the Venturi meter.

e. Materials: All wet surfaces shall be made of 316 stainless steel per applicable ASTM standards. End flanges shall be drilled for AWWA C207 Class B bolting and made of 316 stainless steel. Mill certifications shall be provided for all materials. All welds shall be liquid penetrant inspected (LPI) and a certified report detailing all inspections shall be submitted to the engineer for approval prior to the Venturi meter being shipped to the jobsite.

f. Multivariable Transmitter: The venturi supplier shall provide a Rosemount 3051SMV multi-variable DP transmitter with RTD, Thermowell and 316SS 5-valve instrument manifold. The thermowell shall be located in the recovery cone of the venturi meter and the length of the RTD cable shall be 5.0 feet +/-. The transmitter shall be equipped with a local LCD indicator and stainless-steel mounting bracket. The venturi meter manufacturer shall supply the DP transmitter and provide start-up and training on the complete system.

g. Factory Testing: Each Venturi flow meter shall be hydrostatically tested to 1.5 times design pressure and monitored for 15 minutes to verify the integrity of the primary device. The hydro-test shall be conducted using blind flanges at each end. Certified results of the hydro-test shall be submitted to the engineer for review and approval prior to shipping any equipment.

h. Flow Calibration: Each Venturi meter shall be flow calibrated by an independent flow lab and provided with certified copies of the test results to substantiate the flow meter's accuracy, discharge coefficient and permanent pressure loss. In lieu of lab flow calibration, the manufacturer may provide prior independent lab test data substantiating the flow meter's accuracy, Reynolds number performance, installation effects, discharge coefficient, and head loss. Prior test data shall cover at least 36 lab calibrations in sizes from 2.0 to 48.0".

i. Quality Assurance: The manufacturer of the Venturi meter shall have a minimum of 20 years experience in providing similar differential type flow meters and shall have a current ISO 9001 Certificate of Registration of Quality Management System in the Design and Manufacturing of Flow Measurement Systems. The Venturi meter manufacturer shall have current ASME S&U code stamps to ensure that all welding is performed according to applicable codes. Current certification showing compliance with ISO:9001 and AMSE shall be provided to contractors with proposal.

2. Manufacturers: Provide products of one of the following:

a. Primary Flow Signal

b. Or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Contractor shall require the system supplier to furnish the services of qualified factory-trained servicemen to assist in the installation of the instrumentation and control system equipment.

B. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents. Transmitters and instruments, which require access for periodic calibration or maintenance, shall be mounted so they are accessible while standing on the floor. Care shall be taken in the

installation to ensure sufficient space is provided between instruments and other equipment or piping to allow for easy removal and servicing.

C. All items shall be mounted and anchored using stainless steel hardware, unless otherwise noted.

D. All field instruments shall be rigidly secured to walls, stands or brackets as required by the manufacturer and as shown.

E. Conform to all applicable provisions of the NEMA standards, NEC and local, State and Federal codes when installing the equipment and interconnecting wiring.

3.2 START-UP, CALIBRATION, TESTING, AND TRAINING

A. Comply with the requirements of Section 13401, Process Control System General Provisions, Section 13403, Process Control System Startup and Field Testing, and Section 13404, Process Control System Training.

3.3 TABLE 13420-A, INSTRUMENT LIST

A. Schedules, listed below, following "End of Section" designation, are part of this Specification section:

1. Table 13420-A, Instrument List.

+ + END OF SECTION + +

+ + NO TEXT ON THIS PAGE + +

Section 13420
13420-A- Instrument List

Index	Instrument Tag	Service Description	Instrument Type	P&ID	Process	Pipe Size	Process Range	Switch Setpoint	Power Supply	Location	Area Class	Manufacturer	Model	Supplier	Spec	Comment
0001	PIT-2001A	BLOWER COMMON DISCHARGE HEADER PRESSURE A	Pressure Transmitter	I-PID-3	Air	60"	6 - 15 psig	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0002	PIT-2001B	BLOWER COMMON DISCHARGE HEADER PRESSURE B	Pressure Transmitter	I-PID-3	Air	60"	6 - 15 psig	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0003	PIT-2001C	BLOWER COMMON DISCHARGE HEADER PRESSURE C	Pressure Transmitter	I-PID-3	Air	60"	6 - 15 psig	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0004	AE-2101	AERATION TANK 1 PASS AB DISSOLVED OXYGEN SENSOR	Dissolved Oxygen Sensor	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0005	AIT-2101	AERATION TANK 1 PASS AB DISSOLVED OXYGEN	Dissolved Oxygen Transmitter	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	120 VAC	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0006	FIT-2101	AERATION TANK 1 PASS AB AIR HEADER FLOW	Differential Pressure Transmitter	I-PID-3	Air	24"	3,300 - 12,650 scfm	N/A	24 VDC (Loop)	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0007	FE-2101	AERATION TANK 1 PASS AB AIR HEADER FLOW ELEMENT	Venturi Flow Meter	I-PID-3	Air	24"	By Vendor	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0008	TE-2101	AERATION TANK 1 PASS AB AIR HEADER TEMPERATURE COMPENSATION	Temperature Sensor	I-PID-3	Air	24"	185 - 200 °F	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0009	ZSO-2101	AERATION TANK 1 PASS AB VALVE OPENED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0010	ZSC-2101	AERATION TANK 1 PASS AB VALVE CLOSED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0011	ZIT-2101	AERATION TANK 1 PASS AB VALVE POSITION FEEDBACK	Position Transmitter	I-PID-3	N/A	24"	0 - 100%	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0012	AE-2102	AERATION TANK 1 PASS CD DISSOLVED OXYGEN SENSOR	Dissolved Oxygen Sensor	I-PID-3	Dissolved Oxygen	N/A	0 - 20.0 mg/L	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0013	AIT-2102	AERATION TANK 1 PASS CD DISSOLVED OXYGEN	Dissolved Oxygen Transmitter	I-PID-3	Dissolved Oxygen	N/A	0 - 20.0 mg/L	N/A	120 VAC	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0014	FIT-2102	AERATION TANK 1 PASS CD AIR HEADER FLOW	Differential Pressure Transmitter	I-PID-3	Air	24"	2,760 - 10,580 scfm	N/A	24 VDC (Loop)	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0015	FE-2102	AERATION TANK 1 PASS CD AIR HEADER FLOW ELEMENT	Venturi Flow Meter	I-PID-3	Air	24"	By Vendor	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0016	TE-2102	AERATION TANK 1 PASS CD AIR HEADER TEMPERATURE COMPENSATION	Temperature Sensor	I-PID-3	Air	24"	185 - 200 °F	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0017	ZSO-2102	AERATION TANK 1 PASS CD VALVE OPENED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0018	ZSC-2102	AERATION TANK 1 PASS CD VALVE CLOSED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0019	ZIT-2102	AERATION TANK 1 PASS CD VALVE POSITION FEEDBACK	Position Transmitter	I-PID-3	N/A	24"	0 - 100%	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0020	AE-2201	AERATION TANK 2 PASS CD DISSOLVED OXYGEN SENSOR	Dissolved Oxygen Sensor	I-PID-3	Dissolved Oxygen	N/A	0 - 20.0 mg/L	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0021	AIT-2201	AERATION TANK 2 PASS CD DISSOLVED OXYGEN	Dissolved Oxygen Transmitter	I-PID-3	Dissolved Oxygen	N/A	0 - 20.0 mg/L	N/A	120 VAC	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0022	FIT-2201	AERATION TANK 2 PASS CD AIR HEADER FLOW	Differential Pressure Transmitter	I-PID-3	Air	24"	2,760 - 10,580 scfm	N/A	24 VDC (Loop)	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0023	FE-2201	AERATION TANK 2 PASS CD AIR HEADER FLOW ELEMENT	Venturi Flow Meter	I-PID-3	Air	24"	By Vendor	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0024	TE-2201	AERATION TANK 2 PASS CD AIR HEADER TEMPERATURE COMPENSATION	Temperature Sensor	I-PID-3	Air	24"	185 - 200 °F	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0025	ZSO-2201	AERATION TANK 2 PASS CD VALVE OPENED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0026	ZSC-2201	AERATION TANK 2 PASS CD VALVE CLOSED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0027	ZIT-2201	AERATION TANK 2 PASS CD VALVE POSITION FEEDBACK	Position Transmitter	I-PID-3	N/A	24"	0 - 100%	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0028	AE-2202	AERATION TANK 2 PASS AB DISSOLVED OXYGEN SENSOR	Dissolved Oxygen Sensor	I-PID-3	Dissolved Oxygen	N/A	0 - 20.0 mg/L	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0029	AIT-2202	AERATION TANK 2 PASS AB DISSOLVED OXYGEN	Dissolved Oxygen Transmitter	I-PID-3	Dissolved Oxygen	N/A	0 - 20.0 mg/L	N/A	120 VAC	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0030	FIT-2202	AERATION TANK 2 PASS AB AIR HEADER FLOW	Differential Pressure Transmitter	I-PID-3	Air	24"	3,300 - 12,650 scfm	N/A	24 VDC (Loop)	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0031	FE-2202	AERATION TANK 2 PASS AB AIR HEADER FLOW ELEMENT	Venturi Flow Meter	I-PID-3	Air	24"	By Vendor	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0032	TE-2202	AERATION TANK 2 PASS AB AIR HEADER TEMPERATURE COMPENSATION	Temperature Sensor	I-PID-3	Air	24"	185 - 200 °F	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0033	ZSO-2202	AERATION TANK 2 PASS AB VALVE OPENED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0034	ZSC-2202	AERATION TANK 2 PASS AB VALVE CLOSED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0035	ZIT-2202	AERATION TANK 2 PASS AB VALVE POSITION FEEDBACK	Position Transmitter	I-PID-3	N/A	24"	0 - 100%	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0036	AE-2301	AERATION TANK 3 PASS AB DISSOLVED OXYGEN SENSOR	Dissolved Oxygen Sensor	I-PID-3	Dissolved Oxygen	N/A	0 - 20.0 mg/L	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0037	AIT-2301	AERATION TANK 3 PASS AB DISSOLVED OXYGEN	Dissolved Oxygen Transmitter	I-PID-3	Dissolved Oxygen	N/A	0 - 20.0 mg/L	N/A	120 VAC	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0038	FIT-2301	AERATION TANK 3 PASS AB AIR HEADER FLOW	Differential Pressure Transmitter	I-PID-3	Air	24"	3,300 - 12,650 scfm	N/A	24 VDC (Loop)	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0039	FE-2301	AERATION TANK 3 PASS AB AIR HEADER FLOW ELEMENT	Venturi Flow Meter	I-PID-3	Air	24"	By Vendor	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0040	TE-2301	AERATION TANK 3 PASS AB AIR HEADER TEMPERATURE COMPENSATION	Temperature Sensor	I-PID-3	Air	24"	185 - 200 °F	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0041	ZSO-2301	AERATION TANK 3 PASS AB VALVE OPENED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0042	ZSC-2301	AERATION TANK 3 PASS AB VALVE CLOSED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0043	ZIT-2301	AERATION TANK 3 PASS AB VALVE POSITION FEEDBACK	Position Transmitter	I-PID-3	N/A	24"	0 - 100%	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0044	AE-2302	AERATION TANK 3 PASS CD DISSOLVED OXYGEN SENSOR	Dissolved Oxygen Sensor	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0045	AIT-2302	AERATION TANK 3 PASS CD DISSOLVED OXYGEN	Dissolved Oxygen Transmitter	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	120 VAC	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0046	FIT-2302	AERATION TANK 3 PASS CD AIR HEADER FLOW	Differential Pressure Transmitter	I-PID-3	Air	24"	2,760 - 10,580 scfm	N/A	24 VDC (Loop)	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0047	FE-2302	AERATION TANK 3 PASS CD AIR HEADER FLOW ELEMENT	Venturi Flow Meter	I-PID-3	Air	24"	By Vendor	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0048	TE-2302	AERATION TANK 3 PASS CD AIR HEADER TEMPERATURE COMPENSATION	Temperature Sensor	I-PID-3	Air	24"	185 - 200 °F	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0049	ZSO-2302	AERATION TANK 3 PASS CD VALVE OPENED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0050	ZSC-2302	AERATION TANK 3 PASS CD VALVE CLOSED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0051	ZIT-2302	AERATION TANK 3 PASS CD VALVE POSITION FEEDBACK	Position Transmitter	I-PID-3	N/A	24"	0 - 100%	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0052	AE-2401	AERATION TANK 4 PASS AB DISSOLVED OXYGEN SENSOR	Dissolved Oxygen Sensor	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0053	AIT-2401	AERATION TANK 4 PASS AB DISSOLVED OXYGEN	Dissolved Oxygen Transmitter	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	120 VAC	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0054	FIT-2401	AERATION TANK 4 PASS AB AIR HEADER FLOW	Differential Pressure Transmitter	I-PID-3	Air	24"	3,300 - 12,650 scfm	N/A	24 VDC (Loop)	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0055	FE-2401	AERATION TANK 4 PASS AB AIR HEADER FLOW ELEMENT	Venturi Flow Meter	I-PID-3	Air	24"	By Vendor	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0056	TE-2401	AERATION TANK 4 PASS AB AIR HEADER TEMPERATURE COMPENSATION	Temperature Sensor	I-PID-3	Air	24"	185 - 200 °F	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0057	ZSO-2401	AERATION TANK 4 PASS AB VALVE OPENED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0058	ZSC-2401	AERATION TANK 4 PASS AB VALVE CLOSED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0059	ZIT-2401	AERATION TANK 4 PASS AB VALVE POSITION FEEDBACK	Position Transmitter	I-PID-3	N/A	24"	0 - 100%	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0060	AE-2402	AERATION TANK 4 PASS CD DISSOLVED OXYGEN SENSOR	Dissolved Oxygen Sensor	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0061	AIT-2402	AERATION TANK 4 PASS CD DISSOLVED OXYGEN	Dissolved Oxygen Transmitter	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	120 VAC	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0062	FIT-2402	AERATION TANK 4 PASS CD AIR HEADER FLOW	Differential Pressure Transmitter	I-PID-3	Air	24"	2,760 - 10,580 scfm	N/A	24 VDC (Loop)	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0063	FE-2402	AERATION TANK 4 PASS CD AIR HEADER FLOW ELEMENT	Venturi Flow Meter	I-PID-3	Air	24"	By Vendor	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0064	TE-2402	AERATION TANK 4 PASS CD AIR HEADER TEMPERATURE COMPENSATION	Temperature Sensor	I-PID-3	Air	24"	185 - 200 °F	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0065	ZSO-2402	AERATION TANK 4 PASS CD VALVE OPENED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0066	ZSC-2402	AERATION TANK 4 PASS CD VALVE CLOSED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0067	ZIT-2402	AERATION TANK 4 PASS CD VALVE POSITION FEEDBACK	Position Transmitter	I-PID-3	N/A	24"	0 - 100%	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0068	AE-2501	AERATION TANK 5 PASS AB DISSOLVED OXYGEN SENSOR	Dissolved Oxygen Sensor	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0069	AIT-2501	AERATION TANK 5 PASS AB DISSOLVED OXYGEN	Dissolved Oxygen Transmitter	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	120 VAC	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0070	FIT-2501	AERATION TANK 5 PASS AB AIR HEADER FLOW	Differential Pressure Transmitter	I-PID-3	Air	24"	3,300 - 12,650 scfm	N/A	24 VDC (Loop)	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0071	FE-2501	AERATION TANK 5 PASS AB AIR HEADER FLOW ELEMENT	Venturi Flow Meter	I-PID-3	Air	24"	By Vendor	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0072	TE-2501	AERATION TANK 5 PASS AB AIR HEADER TEMPERATURE COMPENSATION	Temperature Sensor	I-PID-3	Air	24"	185 - 200 °F	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0073	ZSO-2501	AERATION TANK 5 PASS AB VALVE OPENED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0074	ZSC-2501	AERATION TANK 5 PASS AB VALVE CLOSED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0075	ZIT-2501	AERATION TANK 5 PASS AB VALVE POSITION FEEDBACK	Position Transmitter	I-PID-3	N/A	24"	0 - 100%	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0076	AE-2502	AERATION TANK 5 PASS CD DISSOLVED OXYGEN SENSOR	Dissolved Oxygen Sensor	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0077	AIT-2502	AERATION TANK 5 PASS CD DISSOLVED OXYGEN	Dissolved Oxygen Transmitter	I-PID-3	Dissolved Oxygen	N/A	0.01 - 20.0 mg/L	N/A	120 VAC	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0078	FIT-2502	AERATION TANK 5 PASS CD AIR HEADER FLOW	Differential Pressure Transmitter	I-PID-3	Air	24"	2,760 - 10,580 scfm	N/A	24 VDC (Loop)	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0079	FE-2502	AERATION TANK 5 PASS CD AIR HEADER FLOW ELEMENT	Venturi Flow Meter	I-PID-3	Air	24"	By Vendor	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0080	TE-2502	AERATION TANK 5 PASS CD AIR HEADER TEMPERATURE COMPENSATION	Temperature Sensor	I-PID-3	Air	24"	185 - 200 °F	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0081	ZSO-2502	AERATION TANK 5 PASS CD VALVE OPENED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0082	ZSC-2502	AERATION TANK 5 PASS CD VALVE CLOSED	Limit Switch	I-PID-3	N/A	24"	N/A	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0083	ZIT-2502	AERATION TANK 5 PASS CD VALVE POSITION FEEDBACK	Position Transmitter	I-PID-3	N/A	24"	0 - 100%	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0084	AE-2011	AERATION TANK 1 PASS 1D NH3/NO3 SENSOR	Ammonium / Nitrate Sensor	I-PID-4	Ammonia / Nitrate	N/A	0.2 to 1000 mg/L NH4-N 0.2 to 1000 mg/L NO3-N	N/A	N/A	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	NH3 is derived from measured NH4
0085	AIT-2011	AERATION TANK 1 PASS 1D/2D NH3/NO3	Ammonium / Nitrate Transmitter	I-PID-4	Ammonia / Nitrate	N/A	0.2 to 1000 mg/L NH4-N 0.2 to 1000 mg/L NO3-N	N/A	120VAC	Aeration Tank 1	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	NH3 is derived from measured NH4
0086	AE-2012	AERATION TANK 2 PASS 2D NH3/NO3 SENSOR	Ammonium / Nitrate Sensor	I-PID-4	Ammonia / Nitrate	N/A	0.2 to 1000 mg/L NH4-N 0.2 to 1000 mg/L NO3-N	N/A	N/A	Aeration Tank 2	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	NH3 is derived from measured NH4
0087	AE-2013	AERATION TANK 3 PASS 3D NH3/NO3 SENSOR	Ammonium / Nitrate Sensor	I-PID-5	Ammonia / Nitrate	N/A	0.2 to 1000 mg/L NH4-N 0.2 to 1000 mg/L NO3-N	N/A	N/A	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	NH3 is derived from measured NH4
0088	AIT-2013	AERATION TANK 3 PASS 3D NH3/NO3	Ammonium / Nitrate Transmitter	I-PID-5	Ammonia / Nitrate	N/A	0.2 to 1000 mg/L NH4-N 0.2 to 1000 mg/L NO3-N	N/A	120VAC	Aeration Tank 3	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	NH3 is derived from measured NH4
0089	AE-2014	AERATION TANK 4 PASS 4D NH3/NO3 SENSOR	Ammonium / Nitrate Sensor	I-PID-5	Ammonia / Nitrate	N/A	0.2 to 1000 mg/L NH4-N 0.2 to 1000 mg/L NO3-N	N/A	N/A	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	NH3 is derived from measured NH4
0090	AIT-2014	AERATION TANK 4 PASS 4D NH3/NO3	Ammonium / Nitrate Transmitter	I-PID-5	Ammonia / Nitrate	N/A	0.2 to 1000 mg/L NH4-N 0.2 to 1000 mg/L NO3-N	N/A	120VAC	Aeration Tank 4	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	NH3 is derived from measured NH4
0091	AE-2015	AERATION TANK 5 PASS 5D NH3/NO3 SENSOR	Ammonium / Nitrate Sensor	I-PID-6	Ammonia / Nitrate	N/A	0.2 to 1000 mg/L NH4-N 0.2 to 1000 mg/L NO3-N	N/A	N/A	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	NH3 is derived from measured NH4

Section 13420
13420-A- Instrument List

Index	Instrument Tag	Service Description	Instrument Type	P&ID	Process	Pipe Size	Process Range	Switch Setpoint	Power Supply	Location	Area Class	Manufacturer	Model	Supplier	Spec	Comment
0092	AIT-2015	AERATION TANK 5 PASS 5D NH3/NO3	Ammonium / Nitrate Transmitter	I-PID-6	Ammonia / Nitrate	N/A	0.2 to 1000 mg/L NH4-N 0.2 to 1000 mg/L NO3-N	N/A	120VAC	Aeration Tank 5	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	NH3 is derived from measured NH4
0093	PDSH-4501A	BLOWER 1 INLET FILTER 1ST STAGE DIFFERENTIAL PRESSURE SWITCH	Differential Pressure Switch	I-PID-1	Air	N/A	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0094	PDSH-4501B	BLOWER 1 INLET FILTER 2ND STAGE DIFFERENTIAL PRESSURE SWITCH	Differential Pressure Switch	I-PID-1	Air	N/A	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0095	TE-4501	BLOWER 1 INLET TEMPERATURE ELEMENT	Temperature Sensor	I-PID-1	Air	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0096	TIT-4501	BLOWER 1 INLET TEMPERATURE	Temperature Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0097	PIT-4501	BLOWER 1 INLET PRESSURE	Pressure Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0098	PIT-4502	BLOWER 1 DISCHARGE PRESSURE	Pressure Transmitter	I-PID-1	Air	36"	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0099	TE-4502	BLOWER 1 DISCHARGE TEMPERATURE SENSOR	Temperature Sensor	I-PID-1	Air	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0100	TIT-4502	BLOWER 1 DISCHARGE TEMPERATURE	Temperature Transmitter	I-PID-1	Air	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0101	PDIT-4502	BLOWER 1 INLET/OUTLET DIFFERENTIAL PRESSURE	Differential Pressure Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0102	ZSO-4501	BLOWER 1 DISCHARGE VALVE OPENED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0103	ZSC-4501	BLOWER 1 DISCHARGE VALVE CLOSED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0104	ZIT-4501	BLOWER 1 DISCHARGE VALVE POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0105	ZSO-4502	BLOWER 1 BLOW-OFF VALVE OPENED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0106	ZSC-4502	BLOWER 1 BLOW-OFF VALVE CLOSED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0107	ZIT-4502	BLOWER 1 BLOW-OFF VALVE POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0108	IE-4503	BLOWER 1 MOTOR CURRENT ELEMENT	Current Transducer	I-PID-1	N/A	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0109	IT-4503	BLOWER 1 MOTOR CURRENT	Current Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0110	VE-4503X	BLOWER 1 MOTOR X-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0111	VE-4503Y	BLOWER 1 MOTOR Y-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0112	VE-4503Z	BLOWER 1 MOTOR Z-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0113	TE-4503A	BLOWER 1 MOTOR PHASE A WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0114	TE-4503B	BLOWER 1 MOTOR PHASE B WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0115	TE-4503C	BLOWER 1 MOTOR PHASE C WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0116	TE-4503D	BLOWER 1 MOTOR NON-DRIVE END TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0117	TE-4503E	BLOWER 1 MOTOR DRIVE END TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0118	ZIT-4504	BLOWER 1 INLET GUIDE VANES POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0119	ZSO-4504	BLOWER 1 INLET GUIDE VANES OPENED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0120	ZSC-4504	BLOWER 1 INLET GUIDE VANES CLOSED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0121	ZIT-4505	BLOWER 1 VARIABLE DIFFUSER POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0122	ZSO-4505	BLOWER 1 VARIABLE DIFFUSER OPENED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0123	ZSC-4505	BLOWER 1 VARIABLE DIFFUSER CLOSED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0124	TE-4506A	BLOWER 1 GEARBOX TEMPERATURE SENSOR A	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0125	TE-4506B	BLOWER 1 GEARBOX TEMPERATURE SENSOR B	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0126	TE-4506C	BLOWER 1 GEARBOX TEMPERATURE SENSOR C	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0127	TE-4506D	BLOWER 1 GEARBOX TEMPERATURE SENSOR D	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0128	VE-4506A	BLOWER 1 GEARBOX VIBRATION A SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0129	VE-4506B	BLOWER 1 GEARBOX VIBRATION B SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0130	VE-4506C	BLOWER 1 GEARBOX VIBRATION C SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0131	VE-4506D	BLOWER 1 GEARBOX VIBRATION D SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0132	VE-4506E	BLOWER 1 GEARBOX VIBRATION E SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0133	VE-4506F	BLOWER 1 GEARBOX VIBRATION F SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0134	TE-4507	BLOWER 1 DISCHARGE EXPANSION CONE TEMPERATURE SENSOR	Temperature Sensor	I-PID-1	Air	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0135	TIT-4507	BLOWER 1 DISCHARGE EXPANSION CONE TEMPERATURE	Temperature Transmitter	I-PID-1	Air	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0136	SS-4508	BLOWER 1 ZERO SPEED SWITCH	Zero Speed Switch	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0137	LSL-4510	BLOWER 1 LUBE OIL RESERVOIR LOW LEVEL SWITCH	Level Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0138	LSLL-4510	BLOWER 1 LUBE OIL RESERVOIR LOW LOW LEVEL SWITCH	Level Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0139	LI-4510	BLOWER 1 LUBE OIL RESERVOIR LEVEL GAUGE	Level Gauge	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0140	TSL-4510	BLOWER 1 LUBE OIL RESERVOIR TEMPERATURE SWITCH LOW	Temperature Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0141	TE-4510	BLOWER 1 LUBE OIL RESERVOIR TEMPERATURE SENSOR	Temperature Sensor	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0142	TIT-4510	BLOWER 1 LUBE OIL RESERVOIR TEMPERATURE TRANSMITTER	Temperature Transmitter	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0143	ZSO-4513	BLOWER 1 LUBE OIL HEAT EXCHANGER COOLING WATER RETURN VALVE OPENED	Limit Switch	I-PID-2	Cooling Water	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0144	ZSC-4513	BLOWER 1 LUBE OIL HEAT EXCHANGER COOLING WATER RETURN VALVE CLOSED	Limit Switch	I-PID-2	Cooling Water	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0145	PDSH-4515	BLOWER 1 LUBE OIL FILTER DIFFERENTIAL PRESSURE	Differential Pressure Switch	I-PID-2	Lube Oil	By Supplier	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0146	PIT-4517	BLOWER 1 LUBE OIL SUPPLY PRESSURE	Pressure Transmitter	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0147	TE-4517	BLOWER 1 LUBE OIL SUPPLY TEMPERATURE	Temperature Sensor	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0148	TIT-4517	BLOWER 1 LUBE OIL SUPPLY TEMPERATURE	Temperature Transmitter	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0149	PSL-4520	BLOWER 1 MAIN LUBE OIL PUMP DISCHARGE PRESSURE LOW SWITCH	Pressure Switch	I-PID-2	Lube Oil	By Supplier	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0150	FI-4501A	BLOWER 1 MOTOR NON-DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0151	FI-4501B	BLOWER 1 MOTOR DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0152	FI-4501C	BLOWER 1 GEARBOX NON-DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0153	FI-4501D	BLOWER 1 GEARBOX DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0154	PDSH-4551A	BLOWER 2 INLET FILTER 1ST STAGE DIFFERENTIAL PRESSURE SWITCH	Differential Pressure Switch	I-PID-1	Air	N/A	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0155	PDSH-4551B	BLOWER 2 INLET FILTER 2ND STAGE DIFFERENTIAL PRESSURE SWITCH	Differential Pressure Switch	I-PID-1	Air	N/A	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0156	TE-4551	BLOWER 2 INLET TEMPERATURE ELEMENT	Temperature Sensor	I-PID-1	Air	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0157	TIT-4551	BLOWER 2 INLET TEMPERATURE	Temperature Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0158	PIT-4551	BLOWER 2 INLET PRESSURE	Pressure Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0159	PIT-4552	BLOWER 2 DISCHARGE PRESSURE	Pressure Transmitter	I-PID-1	Air	36"	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0160	TE-4552	BLOWER 2 DISCHARGE TEMPERATURE SENSOR	Temperature Sensor	I-PID-1	Air	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0161	TIT-4552	BLOWER 2 DISCHARGE TEMPERATURE	Temperature Transmitter	I-PID-1	Air	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0162	PDIT-4552	BLOWER 2 INLET/OUTLET DIFFERENTIAL PRESSURE	Differential Pressure Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0163	ZSO-4551	BLOWER 2 DISCHARGE VALVE OPENED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0164	ZSC-4551	BLOWER 2 DISCHARGE VALVE CLOSED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0165	ZIT-4551	BLOWER 2 DISCHARGE VALVE POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0166	ZSO-4552	BLOWER 2 BLOW-OFF VALVE OPENED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0167	ZSC-4552	BLOWER 2 BLOW-OFF VALVE CLOSED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0168	ZIT-4552	BLOWER 2 BLOW-OFF VALVE POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0169	IE-4553	BLOWER 2 MOTOR CURRENT ELEMENT	Current Transducer	I-PID-1	N/A	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0170	IT-4553	BLOWER 2 MOTOR CURRENT	Current Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0171	VE-4553X	BLOWER 2 MOTOR X-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0172	VE-4553Y	BLOWER 2 MOTOR Y-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0173	VE-4553Z	BLOWER 2 MOTOR Z-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0174	TE-4553A	BLOWER 2 MOTOR PHASE A WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0175	TE-4553B	BLOWER 2 MOTOR PHASE B WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0176	TE-4553C	BLOWER 2 MOTOR PHASE C WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0177	TE-4553D	BLOWER 2 MOTOR NON-DRIVE END TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0178	TE-4553E	BLOWER 2 MOTOR DRIVE END TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0179	ZIT-4554	BLOWER 2 INLET GUIDE VANES POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0180	ZSO-4554	BLOWER 2 INLET GUIDE VANES OPENED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0181	ZSC-4554	BLOWER 2 INLET GUIDE VANES CLOSED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0182	ZIT-4555	BLOWER 2 VARIABLE DIFFUSER POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0183	ZSO-4555	BLOWER 2 VARIABLE DIFFUSER OPENED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0184	ZSC-4555	BLOWER 2 VARIABLE DIFFUSER CLOSED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0185	TE-4556A	BLOWER 2 GEARBOX TEMPERATURE SENSOR A	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0186	TE-4556B	BLOWER 2 GEARBOX TEMPERATURE SENSOR B	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0187	TE-4556C	BLOWER 2 GEARBOX TEMPERATURE SENSOR C	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0188	TE-4556D	BLOWER 2 GEARBOX TEMPERATURE SENSOR D	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0189	VE-4556A	BLOWER 2 GEARBOX VIBRATION A SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	

Section 13420
13420-A- Instrument List

Index	Instrument Tag	Service Description	Instrument Type	P&ID	Process	Pipe Size	Process Range	Switch Setpoint	Power Supply	Location	Area Class	Manufacturer	Model	Supplier	Spec	Comment
0190	VE-4556B	BLOWER 2 GEARBOX VIBRATION B SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0191	VE-4556C	BLOWER 2 GEARBOX VIBRATION C SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0192	VE-4556D	BLOWER 2 GEARBOX VIBRATION D SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0193	VE-4556E	BLOWER 2 GEARBOX VIBRATION E SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0194	VE-4556F	BLOWER 2 GEARBOX VIBRATION F SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0195	TE-4557	BLOWER 2 DISCHARGE EXPANSION CONE TEMPERATURE SENSOR	Temperature Sensor	I-PID-1	Air	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0196	TIT-4557	BLOWER 2 DISCHARGE EXPANSION CONE TEMPERATURE	Temperature Transmitter	I-PID-1	Air	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0197	SS-4558	BLOWER 2 ZERO SPEED SWITCH	Zero Speed Switch	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0198	LSL-4560	BLOWER 2 LUBE OIL RESERVOIR LOW LEVEL SWITCH	Level Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0199	LSLL-4560	BLOWER 2 LUBE OIL RESERVOIR LOW LOW LEVEL SWITCH	Level Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0200	LI-4560	BLOWER 2 LUBE OIL RESERVOIR LEVEL GAUGE	Level Gauge	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0201	TSL-4560	BLOWER 2 LUBE OIL RESERVOIR TEMPERATURE SWITCH LOW	Temperature Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0202	TE-4560	BLOWER 2 LUBE OIL RESERVOIR TEMPERATURE SENSOR	Temperature Sensor	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0203	TIT-4560	BLOWER 2 LUBE OIL RESERVOIR TEMPERATURE TRANSMITTER	Temperature Transmitter	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0204	ZSO-4563	BLOWER 2 LUBE OIL HEAT EXCHANGER COOLING WATER RETURN VALVE OPENED	Limit Switch	I-PID-2	Cooling Water	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0205	ZSC-4563	BLOWER 2 LUBE OIL HEAT EXCHANGER COOLING WATER RETURN VALVE CLOSED	Limit Switch	I-PID-2	Cooling Water	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0206	PDSH-4565	BLOWER 2 LUBE OIL FILTER DIFFERENTIAL PRESSURE	Differential Pressure Switch	I-PID-2	Lube Oil	By Supplier	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0207	PIT-4567	BLOWER 2 LUBE OIL SUPPLY PRESSURE	Pressure Transmitter	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0208	TE-4567	BLOWER 2 LUBE OIL SUPPLY TEMPERATURE	Temperature Sensor	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0209	TIT-4567	BLOWER 2 LUBE OIL SUPPLY TEMPERATURE	Temperature Transmitter	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0210	PSL-4570	BLOWER 2 MOTOR NON-DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0211	FI-4551A	BLOWER 2 MOTOR DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0212	FI-4551B	BLOWER 2 GEARBOX NON-DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0213	FI-4551C	BLOWER 2 GEARBOX DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0214	FI-4551D	BLOWER 2 MAIN LUBE OIL PUMP DISCHARGE PRESSURE LOW SWITCH	Pressure Switch	I-PID-2	Lube Oil	By Supplier	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0215	PDSH-4601A	BLOWER 3 INLET FILTER 1ST STAGE DIFFERENTIAL PRESSURE SWITCH	Differential Pressure Switch	I-PID-1	Air	N/A	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0216	PDSH-4601B	BLOWER 3 INLET FILTER 2ND STAGE DIFFERENTIAL PRESSURE SWITCH	Differential Pressure Switch	I-PID-1	Air	N/A	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0217	TE-4601	BLOWER 3 INLET TEMPERATURE ELEMENT	Temperature Sensor	I-PID-1	Air	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0218	TIT-4601	BLOWER 3 INLET TEMPERATURE	Temperature Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0219	PIT-4601	BLOWER 3 INLET PRESSURE	Pressure Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0220	PIT-4602	BLOWER 3 DISCHARGE PRESSURE	Pressure Transmitter	I-PID-1	Air	36"	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0221	TE-4602	BLOWER 3 DISCHARGE TEMPERATURE SENSOR	Temperature Sensor	I-PID-1	Air	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0222	TIT-4602	BLOWER 3 DISCHARGE TEMPERATURE	Temperature Transmitter	I-PID-1	Air	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0223	PDIT-4602	BLOWER 3 INLET/OUTLET DIFFERENTIAL PRESSURE	Differential Pressure Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0224	ZSO-4601	BLOWER 3 DISCHARGE VALVE OPENED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0225	ZSC-4601	BLOWER 3 DISCHARGE VALVE CLOSED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0226	ZIT-4601	BLOWER 3 DISCHARGE VALVE POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0227	ZSO-4602	BLOWER 3 BLOW-OFF VALVE OPENED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0228	ZSC-4602	BLOWER 3 BLOW-OFF VALVE CLOSED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0229	ZIT-4602	BLOWER 3 BLOW-OFF VALVE POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0230	IE-4603	BLOWER 3 MOTOR CURRENT ELEMENT	Current Transducer	I-PID-1	N/A	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0231	IT-4603	BLOWER 3 MOTOR CURRENT	Current Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0232	VE-4603X	BLOWER 3 MOTOR X-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0233	VE-4603Y	BLOWER 3 MOTOR Y-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0234	VE-4603Z	BLOWER 3 MOTOR Z-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0235	TE-4603A	BLOWER 3 MOTOR PHASE A WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0236	TE-4603B	BLOWER 3 MOTOR PHASE B WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0237	TE-4603C	BLOWER 3 MOTOR PHASE C WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0238	TE-4603D	BLOWER 3 MOTOR NON-DRIVE END TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0239	TE-4603E	BLOWER 3 MOTOR DRIVE END TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0240	ZIT-4604	BLOWER 3 INLET GUIDE VANES POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	
0241	ZSO-4604	BLOWER 3 INLET GUIDE VANES OPENED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0242	ZSC-4604	BLOWER 3 INLET GUIDE VANES CLOSED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0243	ZIT-4605	BLOWER 3 VARIABLE DIFFUSER POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0244	ZSO-4605	BLOWER 3 VARIABLE DIFFUSER OPENED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0245	ZSC-4605	BLOWER 3 VARIABLE DIFFUSER CLOSED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0246	TE-4606A	BLOWER 3 GEARBOX TEMPERATURE SENSOR A	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0247	TE-4606B	BLOWER 3 GEARBOX TEMPERATURE SENSOR B	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0248	TE-4606C	BLOWER 3 GEARBOX TEMPERATURE SENSOR C	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0249	TE-4606D	BLOWER 3 GEARBOX TEMPERATURE SENSOR D	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0250	VE-4606A	BLOWER 3 GEARBOX VIBRATION A SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0251	VE-4606B	BLOWER 3 GEARBOX VIBRATION B SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0252	VE-4606C	BLOWER 3 GEARBOX VIBRATION C SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0253	VE-4606D	BLOWER 3 GEARBOX VIBRATION D SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0254	VE-4606E	BLOWER 3 GEARBOX VIBRATION E SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0255	VE-4606F	BLOWER 3 GEARBOX VIBRATION F SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0256	TE-4607	BLOWER 3 DISCHARGE EXPANSION CONE TEMPERATURE SENSOR	Temperature Sensor	I-PID-1	Air	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0257	TIT-4607	BLOWER 3 DISCHARGE EXPANSION CONE TEMPERATURE	Temperature Transmitter	I-PID-1	Air	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0258	SS-4608	BLOWER 3 ZERO SPEED SWITCH	Zero Speed Switch	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0259	LSL-4610	BLOWER 3 LUBE OIL RESERVOIR LOW LEVEL SWITCH	Level Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0260	LSLL-4610	BLOWER 3 LUBE OIL RESERVOIR LOW LOW LEVEL SWITCH	Level Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0261	LI-4610	BLOWER 3 LUBE OIL RESERVOIR LEVEL GAUGE	Level Gauge	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0262	TSL-4610	BLOWER 3 LUBE OIL RESERVOIR TEMPERATURE SWITCH LOW	Temperature Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0263	TE-4610	BLOWER 3 LUBE OIL RESERVOIR TEMPERATURE SENSOR	Temperature Sensor	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0264	TIT-4610	BLOWER 3 LUBE OIL RESERVOIR TEMPERATURE TRANSMITTER	Temperature Transmitter	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0265	ZSO-4613	BLOWER 3 LUBE OIL HEAT EXCHANGER COOLING WATER RETURN VALVE OPENED	Limit Switch	I-PID-2	Cooling Water	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0266	ZSC-4613	BLOWER 3 LUBE OIL HEAT EXCHANGER COOLING WATER RETURN VALVE CLOSED	Limit Switch	I-PID-2	Cooling Water	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0267	PDSH-4615	BLOWER 3 LUBE OIL FILTER DIFFERENTIAL PRESSURE	Differential Pressure Switch	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0268	PIT-4617	BLOWER 3 LUBE OIL SUPPLY PRESSURE	Pressure Transmitter	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0269	TE-4617	BLOWER 3 LUBE OIL SUPPLY TEMPERATURE	Temperature Sensor	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0270	TIT-4617	BLOWER 3 LUBE OIL SUPPLY TEMPERATURE	Temperature Transmitter	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0271	FI-4601A	BLOWER 3 MOTOR NON-DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0272	FI-4601B	BLOWER 3 MOTOR DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0273	FI-4601C	BLOWER 3 GEARBOX NON-DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0274	FI-4601D	BLOWER 3 GEARBOX DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0275	PSL-4620	BLOWER 3 MAIN LUBE OIL PUMP DISCHARGE PRESSURE LOW SWITCH	Pressure Switch	I-PID-2	Lube Oil	By Supplier	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0276	PDSH-4651A	BLOWER 4 INLET FILTER 1ST STAGE DIFFERENTIAL PRESSURE SWITCH	Differential Pressure Switch	I-PID-1	Air	N/A	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0277	PDSH-4651B	BLOWER 4 INLET FILTER 2ND STAGE DIFFERENTIAL PRESSURE SWITCH	Differential Pressure Switch	I-PID-1	Air	N/A	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0278	TE-4651	BLOWER 4 INLET TEMPERATURE ELEMENT	Temperature Sensor	I-PID-1	Air	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0279	TIT-4651	BLOWER 4 INLET TEMPERATURE	Temperature Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0280	PIT-4651	BLOWER 4 INLET PRESSURE	Pressure Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0281	PIT-4652	BLOWER 4 DISCHARGE PRESSURE	Pressure Transmitter	I-PID-1	Air	36"	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0282	TE-4652	BLOWER 4 DISCHARGE TEMPERATURE SENSOR	Temperature Sensor	I-PID-1	Air	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0283	TIT-4652	BLOWER 4 DISCHARGE TEMPERATURE	Temperature Transmitter	I-PID-1	Air	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0284	PDIT-4652	BLOWER 4 INLET/OUTLET DIFFERENTIAL PRESSURE	Differential Pressure Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0285	ZSO-4651	BLOWER 4 DISCHARGE VALVE OPENED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0286	ZSC-4651	BLOWER 4 DISCHARGE VALVE CLOSED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0287	ZIT-4651	BLOWER 4 DISCHARGE VALVE POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0288	ZSO-4652	BLOWER 4 BLOW-OFF VALVE OPENED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator

Section 13420
13420-A- Instrument List

Index	Instrument Tag	Service Description	Instrument Type	P&ID	Process	Pipe Size	Process Range	Switch Setpoint	Power Supply	Location	Area Class	Manufacturer	Model	Supplier	Spec	Comment
0289	ZSC-4652	BLOWER 4 BLOW-OFF VALVE CLOSED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0290	ZIT-4652	BLOWER 4 BLOW-OFF VALVE POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0291	IE-4653	BLOWER 4 MOTOR CURRENT ELEMENT	Current Transducer	I-PID-1	N/A	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0292	IT-4653	BLOWER 4 MOTOR CURRENT	Current Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0293	VE-4653X	BLOWER 4 MOTOR X-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0294	VE-4653Y	BLOWER 4 MOTOR Y-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0295	VE-4653Z	BLOWER 4 MOTOR Z-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0296	TE-4653A	BLOWER 4 MOTOR PHASE A WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0297	TE-4653B	BLOWER 4 MOTOR PHASE B WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0298	TE-4653C	BLOWER 4 MOTOR PHASE C WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0299	TE-4653D	BLOWER 4 MOTOR NON-DRIVE END TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0300	TE-4653E	BLOWER 4 MOTOR DRIVE END TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0301	ZIT-4654	BLOWER 4 INLET GUIDE VANES POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0302	ZSO-4654	BLOWER 4 INLET GUIDE VANES OPENED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0303	ZSC-4654	BLOWER 4 INLET GUIDE VANES CLOSED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0304	ZIT-4655	BLOWER 4 VARIABLE DIFFUSER POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0305	ZSO-4655	BLOWER 4 VARIABLE DIFFUSER OPENED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0306	ZSC-4655	BLOWER 4 VARIABLE DIFFUSER CLOSED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0307	TE-4656A	BLOWER 4 GEARBOX TEMPERATURE SENSOR A	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0308	TE-4656B	BLOWER 4 GEARBOX TEMPERATURE SENSOR B	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0309	TE-4656C	BLOWER 4 GEARBOX TEMPERATURE SENSOR C	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0310	TE-4656D	BLOWER 4 GEARBOX TEMPERATURE SENSOR D	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0311	VE-4656A	BLOWER 4 GEARBOX VIBRATION A SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0312	VE-4656B	BLOWER 4 GEARBOX VIBRATION B SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0313	VE-4656C	BLOWER 4 GEARBOX VIBRATION C SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0314	VE-4656D	BLOWER 4 GEARBOX VIBRATION D SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0315	VE-4656E	BLOWER 4 GEARBOX VIBRATION E SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0316	VE-4656F	BLOWER 4 GEARBOX VIBRATION F SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0317	TE-4657	BLOWER 4 DISCHARGE EXPANSION CONE TEMPERATURE SENSOR	Temperature Sensor	I-PID-1	Air	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0318	TIT-4657	BLOWER 4 DISCHARGE EXPANSION CONE TEMPERATURE	Temperature Transmitter	I-PID-1	Air	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0319	SS-4658	BLOWER 4 ZERO SPEED SWITCH	Zero Speed Switch	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0320	LSL-4660	BLOWER 4 LUBE OIL RESERVOIR LOW LEVEL SWITCH	Level Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0321	LSLL-4660	BLOWER 4 LUBE OIL RESERVOIR LOW LOW LEVEL SWITCH	Level Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0322	LI-4660	BLOWER 4 LUBE OIL RESERVOIR LEVEL GAUGE	Level Gauge	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0323	TSL-4660	BLOWER 4 LUBE OIL RESERVOIR TEMPERATURE SWITCH LOW	Temperature Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0324	TE-4660	BLOWER 4 LUBE OIL RESERVOIR TEMPERATURE SENSOR	Temperature Sensor	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0325	TIT-4660	BLOWER 4 LUBE OIL RESERVOIR TEMPERATURE TRANSMITTER	Temperature Transmitter	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0326	ZSO-4663	BLOWER 4 LUBE OIL HEAT EXCHANGER COOLING WATER RETURN VALVE OPENED	Limit Switch	I-PID-2	Cooling Water	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0327	ZSC-4663	BLOWER 4 LUBE OIL HEAT EXCHANGER COOLING WATER RETURN VALVE CLOSED	Limit Switch	I-PID-2	Cooling Water	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0328	PDSH-4665	BLOWER 4 LUBE OIL FILTER DIFFERENTIAL PRESSURE	Differential Pressure Switch	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0329	PIT-4667	BLOWER 4 LUBE OIL SUPPLY PRESSURE	Pressure Transmitter	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0330	TE-4667	BLOWER 4 LUBE OIL SUPPLY TEMPERATURE	Temperature Sensor	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0331	TIT-4667	BLOWER 4 LUBE OIL SUPPLY TEMPERATURE	Temperature Transmitter	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0332	FI-4651A	BLOWER 4 MOTOR NON-DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0333	FI-4651B	BLOWER 4 MOTOR DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0334	FI-4651C	BLOWER 4 GEARBOX NON-DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0335	FI-4651D	BLOWER 4 GEARBOX DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0336	PSL-4670	BLOWER 4 MAIN LUBE OIL PUMP DISCHARGE PRESSURE LOW SWITCH	Pressure Switch	I-PID-2	Lube Oil	By Supplier	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0337	PDSH-4701A	BLOWER 5 INLET FILTER 1ST STAGE DIFFERENTIAL PRESSURE SWITCH	Differential Pressure Switch	I-PID-1	Air	N/A	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0338	PDSH-4701B	BLOWER 5 INLET FILTER 2ND STAGE DIFFERENTIAL PRESSURE SWITCH	Differential Pressure Switch	I-PID-1	Air	N/A	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0339	TE-4701	BLOWER 5 INLET TEMPERATURE ELEMENT	Temperature Sensor	I-PID-1	Air	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0340	TIT-4701	BLOWER 5 INLET TEMPERATURE	Temperature Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0341	PIT-4701	BLOWER 5 INLET PRESSURE	Pressure Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0342	PIT-4702	BLOWER 5 DISCHARGE PRESSURE	Pressure Transmitter	I-PID-1	Air	36"	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0343	TE-4702	BLOWER 5 DISCHARGE TEMPERATURE SENSOR	Temperature Sensor	I-PID-1	Air	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0344	TIT-4702	BLOWER 5 DISCHARGE TEMPERATURE	Temperature Transmitter	I-PID-1	Air	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0345	PDIT-4702	BLOWER 5 INLET/OUTLET DIFFERENTIAL PRESSURE	Differential Pressure Transmitter	I-PID-1	Air	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0346	ZSO-4701	BLOWER 5 DISCHARGE VALVE OPENED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0347	ZSC-4701	BLOWER 5 DISCHARGE VALVE CLOSED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0348	ZIT-4701	BLOWER 5 DISCHARGE VALVE POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0349	ZSO-4702	BLOWER 5 BLOW-OFF VALVE OPENED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0350	ZSC-4702	BLOWER 5 BLOW-OFF VALVE CLOSED	Limit Switch	I-PID-1	N/A	36"	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0351	ZIT-4702	BLOWER 5 BLOW-OFF VALVE POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	36"	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0352	IE-4703	BLOWER 5 MOTOR CURRENT ELEMENT	Current Transducer	I-PID-1	N/A	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0353	IT-4703	BLOWER 5 MOTOR CURRENT	Current Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0354	VE-4703X	BLOWER 5 MOTOR X-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0355	VE-4703Y	BLOWER 5 MOTOR Y-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0356	VE-4703Z	BLOWER 5 MOTOR Z-AXIS VIBRATION	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0357	TE-4703A	BLOWER 5 MOTOR PHASE A WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0358	TE-4703B	BLOWER 5 MOTOR PHASE B WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0359	TE-4703C	BLOWER 5 MOTOR PHASE C WINDING TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0360	TE-4703D	BLOWER 5 MOTOR NON-DRIVE END TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0361	TE-4703E	BLOWER 5 MOTOR DRIVE END TEMPERATURE	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0362	ZIT-4704	BLOWER 5 INLET GUIDE VANES POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0363	ZSO-4704	BLOWER 5 INLET GUIDE VANES OPENED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0364	ZSC-4704	BLOWER 5 INLET GUIDE VANES CLOSED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0365	ZIT-4705	BLOWER 5 VARIABLE DIFFUSER POSITION FEEDBACK	Position Transmitter	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0366	ZSO-4705	BLOWER 5 VARIABLE DIFFUSER OPENED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0367	ZSC-4705	BLOWER 5 VARIABLE DIFFUSER CLOSED	Limit Switch	I-PID-1	N/A	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0368	TE-4706A	BLOWER 5 GEARBOX TEMPERATURE SENSOR A	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0369	TE-4706B	BLOWER 5 GEARBOX TEMPERATURE SENSOR B	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0370	TE-4706C	BLOWER 5 GEARBOX TEMPERATURE SENSOR C	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0371	TE-4706D	BLOWER 5 GEARBOX TEMPERATURE SENSOR D	Temperature Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0372	VE-4706A	BLOWER 5 GEARBOX VIBRATION A SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0373	VE-4706B	BLOWER 5 GEARBOX VIBRATION B SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0374	VE-4706C	BLOWER 5 GEARBOX VIBRATION C SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0375	VE-4706D	BLOWER 5 GEARBOX VIBRATION D SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0376	VE-4706E	BLOWER 5 GEARBOX VIBRATION E SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0377	VE-4706F	BLOWER 5 GEARBOX VIBRATION F SENSOR	Vibration Sensor	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0378	TE-4707	BLOWER 5 DISCHARGE EXPANSION CONE TEMPERATURE SENSOR	Temperature Sensor	I-PID-1	Air	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0379	TIT-4707	BLOWER 5 DISCHARGE EXPANSION CONE TEMPERATURE	Temperature Transmitter	I-PID-1	Air	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0380	SS-4708	BLOWER 5 ZERO SPEED SWITCH	Zero Speed Switch	I-PID-1	N/A	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0381	LSL-4710	BLOWER 5 LUBE OIL RESERVOIR LOW LEVEL SWITCH	Level Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0382	LSLL-4710	BLOWER 5 LUBE OIL RESERVOIR LOW LOW LEVEL SWITCH	Level Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0383	LI-4710	BLOWER 5 LUBE OIL RESERVOIR LEVEL GAUGE	Level Gauge	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0384	TSL-4710	BLOWER 5 LUBE OIL RESERVOIR TEMPERATURE SWITCH LOW	Temperature Switch	I-PID-2	Lube Oil	N/A	By Supplier	By Supplier	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0385	TE-4710	BLOWER 5 LUBE OIL RESERVOIR TEMPERATURE SENSOR	Temperature Sensor	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0386	TIT-4710	BLOWER 5 LUBE OIL RESERVOIR TEMPERATURE TRANSMITTER	Temperature Transmitter	I-PID-2	Lube Oil	N/A	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	11610	
0387	ZSO-4713	BLOWER 5 LUBE OIL HEAT EXCHANGER COOLING WATER RETURN VALVE OPENED	Limit Switch	I-PID-2	Cooling Water	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator

Section 13420
13420-A- Instrument List

Index	Instrument Tag	Service Description	Instrument Type	P&ID	Process	Pipe Size	Process Range	Switch Setpoint	Power Supply	Location	Area Class	Manufacturer	Model	Supplier	Spec	Comment
0388	ZSC-4713	BLOWER 5 LUBE OIL HEAT EXCHANGER COOLING WATER RETURN VALVE CLOSED	Limit Switch	I-PID-2	Cooling Water	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	15100	Supplied with actuator
0389	PDSH-4715	BLOWER 5 LUBE OIL FILTER DIFFERENTIAL PRESSURE	Differential Pressure Switch	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0390	PIT-4717	BLOWER 5 LUBE OIL SUPPLY PRESSURE	Pressure Transmitter	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0391	TE-4717	BLOWER 5 LUBE OIL SUPPLY TEMPERATURE	Temperature Sensor	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0392	TIT-4717	BLOWER 5 LUBE OIL SUPPLY TEMPERATURE	Temperature Transmitter	I-PID-2	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0393	FI-4701A	BLOWER 5 MOTOR NON-DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0394	FI-4701B	BLOWER 5 MOTOR DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0395	FI-4701C	BLOWER 5 GEARBOX NON-DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0396	FI-4701D	BLOWER 5 GEARBOX DRIVE END LUBE OIL FLOW INDICATOR	Flow Indicator	I-PID-1	Lube Oil	By Supplier	By Supplier	N/A	N/A	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	
0397	PSL-4720	BLOWER 5 MAIN LUBE OIL PUMP DISCHARGE PRESSURE LOW SWITCH	Pressure Switch	I-PID-2	Lube Oil	By Supplier	By Supplier	By Supplier	24 VDC (Loop)	Aeration Blower Facility	Unclassified	By Supplier	By Supplier	Aeration Blower Supplier	13420	

NOTES:

1. I-PID-1 depicts Blower 1. Instrumentation is typical for Blowers 2, 3, 4, and 5.

NO TEXT ON THIS PAGE

SECTION 13430

PROCESS CONTROL PANELS AND ENCLOSURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place into satisfactory operation the control panels and enclosures required for a fully functional PCS.

2. Major Panels/Enclosures/Cabinets specified under this Section include:

   a. Aeration Control Panel (ACP) NEMA 12

   b. Blower 1 Local Control Panel (BLW-LCP-1) NEMA 12

   c. Blower 2 Local Control Panel (BLW-LCP-2) NEMA 12

   d. Blower 3 Local Control Panel (BLW-LCP-3) NEMA 12

   e. Blower 4 Local Control Panel (BLW-LCP-4) NEMA 12

   f. Blower 5 Local Control Panel (BLW-LCP-5) NEMA 12

B. Related Sections:

1. Section 02200, Earthwork

2. Section 03300, Cast-In-Place Concrete.

3. Section 05051, Anchor Systems.

4. Section 11610, Direct Drive Single-Stage Centrifugal Blowers

5. Section 13401, Process Control System General Provisions.

6. Section 13402, Process Control System Factory Testing.

7. Section 13403, Process Control System Start up and Field Testing.

8. Section 13440, Panel Mounted Instruments and Devices.

9. Section 13451, PLC Hardware and Software.

10. Division 11, Equipment.

11. Division 16, Electrical.

1.2 QUALITY ASSURANCE

A. Standards, Codes and Regulations:

1. Construction of panels and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes and regulations:

   a. National Fire Protection Association 79, Annex "D" Standards, (NFPA).

   b. National Electrical Code, (NEC).

   c. National Electrical Manufacturer's Association Standards, (NEMA).

   d. American Society for Testing and Materials, (ASTM).

   d. Operational Safety and Health Administration Regulations, (OSHA).

   e. Underwriters' Laboratory, Inc., (UL).

   f. State and Local code requirements.

   g. Where any conflict arises between codes or standards, the more stringent requirement shall apply.

2. All materials and equipment shall be new and all panels shall be built in an Underwriters' Laboratory, Inc. (UL) approved panel shop and bear the UL label.

   a. UL 508A certification is required

B. General Design Requirements:

1. Comply with the requirements of Section 13401, Process Control System General Provisions.

C. Factory Assembly and Testing:

1. Comply with the requirements of Section 13402, Process Control System Factory Testing.

1.3 SUBMITTALS

A. Comply with the requirements of Section 13401, Process Control System General Provisions.

1.4 DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 13401, Process Control System General Provisions.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION REQUIREMENTS

A. Provide all electrical components and devices, support hardware, fasteners, interconnecting wiring and/or piping required to make the control panels and/or enclosures complete and operational.

B. Locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.

C. Components for installation on panel exterior shall be located generally as shown. Layouts shall be submitted for review in accordance with Section 13401, Process Control System General Provisions.

D. Panels and enclosures shall have full height front access doors.

E. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.

F. Provide sub-panels for installation of all relays and other internally mounted components.

G. All wiring to panel connections from field instruments, devices, and other panels shall be terminated at master numbered terminal strips, unless otherwise specified.

H. Provide copper grounding studs for all panel equipment.

I. Provide the following convenience accessories inside of each control panel:
   1. One 120 VAC, 20A duplex, DIN-rail mount GFCI type receptacle.

2. One or more 120 VAC LED light fixtures with lamp and protective plastic shield to span across the width of the panel but not less than two-thirds the width of the panel, as a minimum. Include snap switch, to turn on the light

3. One 120 VAC, 20A, DIN-rail mount type receptacle for UPS connection.

4. One Make Before Break Switch as UPS bypass switch.

5. Service light with switch and duplex receptacle shall have its own circuit breaker and separate power feed.

J. The bottom 12-inches of free standing panels shall be free of all devices, including terminal strips, to provide ease of installation and testing.

K. No device shall be mounted less than 36-inches above the operating floor level, unless otherwise specified.

2.2 IDENTIFICATION

A. Provide laminated plastic nameplates for identification of panels and components mounted thereon as follows:
1. Nameplates shall be of 3/32-inch thick laminated phenolic type with white matte finish surface and black letter engraving.
2. Panel identification nameplates to have 1/2-inch high letter engravings.
3. Panel mounted component (e.g., control devices, indicating lights, selector switches, etc.) identification nameplates to have 1/4-inch high letter engravings.
4. Nameplates shall be attached to the panel face with two stainless steel self-tapping screws.
5. Nameplate engravings shall include the instrument or equipment tag number and descriptive title as shown and specified.

B. Tag all internally mounted instruments in accordance with the following requirements:
1. Tag numbers shall be as listed in the Instrument Index.
2. The identifying tag number shall be permanently etched or embossed onto a laminated phenolic tag with white matte finish surface which shall be fastened to the device housing with stainless steel rivets or self tapping screws of appropriate size.
3. Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circlet of 1/16-inch diameter stainless steel wire rope.
4. Identification tag shall be installed so that the numbers are easily visible to service personnel.

5. Front of panel mounted instruments shall have the tag attached to rear of device.

C. Tagging of the following items shall be accomplished with the use of adhesive plastic Brady USA, Inc. labels, or equal.
   1. Tag all electrical devices (e.g., relays, timers, power supplies) mounted within control panels and enclosures.
   2. Numerically tag all terminal blocks on terminal strips.
   3. Color code and numerically tag wiring at each end.

Color coding shall be as per the Panel Wiring Color Code Table below:

DESCRIPTION	COLOR
110 VAC PANEL POWER BEFORE AND FUSES OR BREAKERS	BLACK
CONTROLLED 110VAC POWER (i.e., AFTER RELAY CONTACTS, SELECTOR SWITCH CONTACTS, etc.)	RED
110 VAC POWER SOURCE FROM DEVICES EXTERNAL TTO PANEL	YELLOW
110 VAC NEUTRAL	WHITE
24 VDC POSITIVE POWER FROM POWER SUPPLIES	BROWN
24 VDC NEGATIVE POWER FROM POWER SUPPLIES	Not defined
CONTROLLED 24 VDC POWER (i.e., AFTER PLC OUTPUT CONTACTS, RELAY CONTACTS, etc.)	BLUE
24 VDC POSITIVE POWER FROM DEVICES EXTERNAL TO PANEL	ORANGE
24 VDC NEGATIVE POWER FROM DEVICES EXTERNAL TO PANEL	Not defined
24 VDC 4-20 mADC SIGNAL CABLE	GREY WITH RED POSITIVE, CLEAR NEGATIVE
GROUNDING WIRE	GREEN

2.3 PANELS AND ENCLOSURES

A. General:
   1. Panels and enclosures shall meet the NEMA requirements for the type specified.
   2. Sizes shown are estimates. Contractor shall furnish panels and enclosures amply sized to house all equipment, instruments, front panel mounted

devices, power supplies, power distribution panels, wiring, tubing and other components installed within, as required.

3. Network rack equipment shall comply with Section 13461, Control and Data Equipment.

B. Construction Features:

1. Control panels located inside control or electrical room areas shall be NEMA 12 rated.
   a. Fabricate enclosures using minimum 14-gage type steel for wall or frame mounted enclosures and minimum 12-gage type for free standing enclosures. Steel shall be free of pitting and surface blemishes.
   b. Continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.
   c. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
   d. Panel shall be flat within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Flatness shall be checked by using a 72-inch long straight edge. Out-of-flatness shall be gradual, in one direction only, and shall not consist of obvious depressions or a series of wavy sections.
   e. Use pan type construction for doors. Door widths shall not exceed 36-inches.
   f. Mount doors with full-length heavy-duty piano hinge with stainless steel hinge pins.
   g. Provide oil resistant gasket completely around each door or opening.
   h. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.
   i. Use stainless steel fasteners throughout.
   j. Provide interior mounting panels and shelves constructed of minimum 12-gage type steel with a white enamel finish.
   k. Provide steel print pocket with white enamel finish.
   l. Provide enclosure mounting supports as required for floor, frame, or wall mounting.
   m. Provide all holes and cutouts for installation of conduit and equipment. Cable and piping to enter the enclosure through the bottom, unless otherwise noted. All conduit and piping openings and all conduits shall be sealed watertight.
   n. Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Zinc phosphatize for corrosion protection.
   o. One coat of primer shall be applied to all interior and exterior surfaces immediately after corrosion protection has been applied. Exterior surfaces shall then be given sufficient coats of primer surfacer, applied

with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.

p. All interior surfaces shall be painted with two coats of semi-gloss white polyurethane enamel.

q. All exterior surfaces shall be painted with a minimum of three finish coats of polyurethane enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected by Engineer from complete selection of standard and custom color charts furnished by the manufacturer. Provide one extra quart of touch-up paint for each exterior finish color selected selected.

r. Primer and finish paint shall be compatible and shall be a low VOC, high solids polyurethane enamel, Hi-Solids Polyurethane B65 W300 Series as manufactured by Sherwin-Williams, Inc. or equal.

s. Provide one extra quart of touch-up paint for each exterior finish color selected.

2. Control panels located in field shall be NEMA 4X rated.
   a. Panels shall be Type 316L stainless steel construction with a minimum thickness of 12-gage type for all surfaces (except those areas requiring reinforcement) having a smooth brushed finish.
   b. Stainless steel screw clamp assemblies on three sides of each door.
   c. Rolled lip around three sides of door and along top of enclosure opening.
   d. Hasp and staple for padlocking.
   e. Provide a clear plastic, gasketed lockable hinged door to encompass all non-NEMA 4 front of panel instruments.
   f. Provide 3-inch high channel base assembly, with solid bottom, drilled to mate the panel to its floor pad.
   g. Floor Pad: Refer to Part 3 of this Section.
3. Field Panels (NEMA 7):
   a. General: Explosion-proof control enclosures shall be used to house monitoring and measuring devices in hazardous environments. Enclosures shall be suitable for use in NEC Class 1, Groups C and D or Class II, Groups E, F and G applications and comply with UL and CSA standards.
   b. Required Features:
      1) Light weight and corrosion resistant copper-free aluminum.
      2) Integral, cast-on mounting lugs.
      3) Left side door hinges.
      4) Viewing windows sized to suit internally mounted components.
      5) Stainless steel cover bolts.
      6) Zinc-nickel steel mounting pans.
   c. Manufacturers: Provide explosion-proof control enclosures of one of the following:
      1. Adalet.
      2. Or equal.

4. Where the application applies and with the approval of Engineer, wall mounted enclosures may be provided. The enclosure shall comply with Paragraph B.1., B.2. or B.3., except for the following:
   a. Locations shall be as shown on or as specified under other Sections.
   b. Panels may be all fiberglass, polycarbonate or ABS.
   c. Doors shall be full height.
   d. Corrosion resistant polyester quick release latches shall be provided.
   e. No extra holes or knockouts shall be provided. No light or convenience outlet need be provided.

C. Electrical Systems:
   1. Control of Environment:
      a. Outdoor Panels:
         1) Provide adequately sized automatically controlled 120 VAC strip heaters to maintain temperature inside each enclosure above 40ºF to maximum of 80ºF when the outside temperature is -20ºF through 40º F.
         2) Provide automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclosure. Air conditioner shall have a minimum capacity of 4,000 BTU. Housing shall be constructed of corrosion resistant materials.
         3) Provide thermostats to automatically control heating and cooling requirements without need of manual operation of a heating/cooling transfer switch.
         4) Provide calculations if any of the above is deemed unnecessary.
      b. Indoor Panels:
         1) Provide adequately sized, automatically controlled 120 VAC strip heaters to maintain temperature 10ºF above ambient for condensation prevention inside panels.
         2) Provide automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclosure.
            Air conditioner shall have a minimum capacity of 4,000 BTU.
         3) Provide calculations if any of the above is deemed unnecessary.
   2. Power Source and Internal Power Distribution:
      a. General: Control panel power supply source, type, voltage, number of circuits and circuit ratings shall be as shown.
      b. Panels shall be provided with an internal 120 VAC power distribution panel with number of circuits and separate circuit breakers sized as required to distribute power to the panel components and field

instruments. Distribution panel shall contain two spare breakers, minimum.

3. Wiring:
   a. Internal wiring shall be Type MTW and THW stranded copper wire with thermoplastic insulation rated for 600V at 90ºC for single conductors, color coded and labeled with wire identification.
   b. For DC panel signal wiring, use No. 18 minimum AWG shielded.
   c. For DC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 14 minimum AWG. For wiring carrying more than 15 A, use sizes required by NEC standards.
   d. Separate and shield low voltage signal wiring from power and control wiring by a minimum of 6-inches.
   e. Group or bundle parallel runs of wire using covered troughs. Maximum bundle size to be 1-inch. Troughs shall have 40 percent spare capacity.
   f. Install wire troughs as shown on panel layout drawing. Wire trough spacing and layout shall present a neat appearance. Angled runs are not acceptable.
   g. Adequately support and restrain all wiring runs to prevent sagging or other movement.
   h. Terminate all internal panel wiring using screw type terminal blocks mounted on DIN rails. Fused terminal blocks shall have LED blown fuse indication. Terminal blocks for 4-20 mA signals shall be fused and knife disconnect terminal blocks. Terminal strips shall be identified as specified in 2.2.C.3. Identifiers shall be self-stick, plastic tape strips with permanent type, machine printed numbers. Hand-written labels are not acceptable.
   i. All wiring shall be installed such that if wires are removed from any one device, power will not be disrupted to any other device.
   j. Within the enclosure all I/O racks, processor racks, and power supplies shall be grounded and mounted to meet the manufacturer's specifications.
   k. Provide interposing relays for all 24 volt and 120 volt PLC outputs.
   l. Provide individual fuses for all analog and digital inputs and all analog outputs. Fuses shall be capable of being inspected without removal of and replaced without disassembly of the terminal block. Blown fuse LED status indicators shall be provided.
   m. All alarms generated external to the panel, spare alarm, and repeat contacts shall be wired out to terminal blocks.
   n. For internal component-to-component wiring only, compression type terminal blocks are acceptable.
   o. Provide spare terminals equal in number to 20 percent of the terminals used for each type of wiring (e.g., DC signal and AC power).
   p. Provide a separate terminal for grounding each shielded cable.

q. Use separate 5/16-inch diameter copper grounding studs for instrument signal cable shields and AC power.
r. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
s. When DC power and/or low voltage AC power is required, provide and install the necessary power supplies and transformers in the panel.
t. Provide circuit breakers to protect each circuit, with no more than two instruments on a single circuit.
u. Common, push to test circuitry shall be provided for each panel with more than six indicating lights to simultaneously test all indicating lights on the panel using a single pushbutton.
v. Provide complete wiring diagram showing "as-built" circuitry. Diagram shall be enclosed in transparent plastic and placed in easily accessible pocket built into panel door.

4. Corrosion Control:
   a. Panels shall be protected from internal corrosion by the use of corrosion-inhibiting vapor capsules as manufactured by Northern Technologies International Corporation, Model Zerust VC; Hoffman Model AHCI; or equal.
5. Surge Protection:
   a. General - Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines from lightning, utility, or the plant electrical system. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level. Protection shall be maintenance free and self-restoring. Devices shall have a response time of less than 50 nanoseconds and be capable of handling a discharge surge current (at an 8x20µs impulse waveform) of at least 8 kA. Ground wires for all instrumentation device surge protectors shall be connected to a low resistance ground.
   b. Provide protection of all analog signal (4-20 mA) circuits. Circuits shall be protected at both the transmitter and the control system end of the circuit. Protection devices located near the transmitter shall be mounted in the conduit or on the instrument itself, no separate enclosures shall be provided. At the control system end, Units shall be pluggable, DIN-rail mounted. Units shall include local and remote fail indication. Provide a Phoenix Contact or approved equal.
   c. Provide protection of all 120 vac power feeds at outdoor field mounted devices control panels, instruments, and control room equipment. Protection devices located near the transmitter shall be mounted in the conduit or on the instrument itself, no separate enclosures shall be provided. At the control system end, Units shall be pluggable, DIN-rail mounted. Units shall include local and remote fail indication. Provide a Phoenix Contact or approved equal.

d. Non-Fiber Based Data Highway – Provide protection on all data highway circuits (e.g. DeviceNet) that leave a building or are routed external to a building. Circuit protection shall be provided at both ends of the line. Surge protection devices shall be Phoenix Contact PlugTrab Series, Transtector FSP Series, MTL Surge Technologies (Telematic) NP Series, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in conformance with NEC.

B. Unless otherwise noted, install indoor NEMA 4X panels on 4-inch concrete pad. Extend pad 4-inches beyond outside dimensions of base, all sides. Lay grout after panel sills have been securely fastened down.

C. Unless otherwise noted, install outdoor NEMA 4X panels on a reinforced concrete pedestal:
   1. Minimum Thickness: Eight-inches with No. 4 steel reinforcing bars at 12-inches on centers, each way.
   2. Minimum Size: Twelve-inches larger than outer dimensions of base, all sides.
   3. Provide excavation and backfill work in conformance with Section 02200, Earthwork.
   4. Provide concrete work in conformance with Section 03300, Cast-In-Place Concrete.

D. Install anchor bolts and anchor in accordance with Section 05051, Anchor Systems.

E. Install and interconnect all equipment, devices, electrical hardware, instrumentation and controls and process controller components into and out of and among the enclosures as indicated on the Drawings.

3.2 TESTING AND ADJUSTMENTS

A. Perform system testing and make any adjustments necessary in accordance with this Section, Section 13401, Process Control System General Provisions, Section 13402, Process Control System Factory Testing, and Section 13403, Process Control System Start up and Field Testing.

B. Perform power supply, voltage adjustments to tolerances required by the appurtenant equipment.

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SECTION 13440

PANEL MOUNTED INSTRUMENTS AND DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation panel instruments and devices.

2. Contract Documents illustrate and specify functional and general construction requirements of the panel instruments and do not necessarily show or specify all wiring, piping and accessories required to make a completely integrated system. Contractor shall provide all piping, wiring, accessories and labor required for a complete, workable and integrated system that meets the functional requirements shown and specified.

B. Coordination:

1. Coordinate the installation and interface requirements of all items specified herein and required with the manufacturer of equipment specified in other sections to ensure the complete and proper interfacing of all the components and systems.

2. Comply with the requirements of Section 13401, Process Control System General Provisions.

3. Provide Programmable Logic Controller (PLC), Operator Interface Terminal (OIT) and associated software in accordance with specification Section 13451, PLC Hardware and Software.

1.2 QUALITY ASSURANCE

A. Comply with the requirements of Section 13401, Process Control System General Provisions.

B. Acceptable Manufacturers:

1. Furnish instruments and devices by the named manufacturers or equal equipment by other manufacturers.

2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.

3. Obtain all instruments or devices of a given type from the same manufacturer.

C. Manufacturers' Responsibilities and Services:

1. Design and manufacture panels with the instruments and devices installed in accordance with the applicable general design requirements specified in Section 13401, Process Control System General Provisions, and the detailed Specifications herein.

2. Field supervision, inspection, start-up and training in accordance with the requirements of Section 13403, Process Control System Start up and Field Testing, and Section 13404, Process Control System Training.

1.03 SUBMITTALS

A. Comply with the requirements of Section 13401, Process Control System General Provisions, and the following:

1. Shop drawings for uninterruptible power system (UPS) shall include the power ratings of all associated equipment the system shall provide power to. Information shall be in list form and include: equipment name and power rating at maximum load, in Watts, for each item. The list shall tally the power ratings and clearly display that the proposed UPS meets the required output capacity, including specified percent spare, for the specified time requirements. A separate list shall be provided for each required UPS.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements specified in Section 13401, Process Control System General Provisions.

B. Instruments and devices shall not be assembled in the panels until all product information and system Shop Drawings for respective components have been approved.

1.05 IDENTIFICATION TAGS

A. All panel instruments and devices shall have an identification tag meeting the following requirements:

1. Tag numbers shall be as listed in the Instrument Index.

2. Identifying tag number shall be permanently etched or embossed onto a plastic tag which shall be fastened to the device housing with stainless steel rivets or self tapping screws of appropriate size.

3. Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circlet of 1/16-inch diameter stainless steel wire rope.

4. All instruments and devices mounted within panels shall have identification tags, which comply with the requirements specified in Section 13430, Process Control Panels and Enclosures, Article 2.2.C.

5. Tags shall be installed so that the numbers are easily visible to service personnel. Front of panel mounted components shall have the tag attached to the rear of the device.

6. Front of panel mounted components shall have nameplates, which comply with the requirements specified in Section 13430, Process Control Panels and Enclosures.

PART 2 PRODUCTS

2.01 POWER SUPPLIES

A. Provide a 24 VDC power supply in the control panel to power field instruments, panel devices, etc., as required. Equip the power supply with a power on/off circuit breaker.

B. The 24 VDC power supply shall meet the following requirements:

1. Input power: 115 vac, plus or minus 10 percent, 60 Hz.

2. Output voltage: 24 vdc.

3. Output voltage adjustment: 5 percent.

4. Line regulation: 0.05 percent for 10 V line change.

5. Load regulation: 0.15 percent no load to full load.

6. Ripple: 3 mV RMS.

7. Operating temperature: 32 to 140 degrees Fahrenheit.

8. DIN rail mounting.

9. Integrated Selective Fused Breaking

C. Size the 24 vdc power supply to accommodate the design load plus a minimum 25 percent spare capacity.

D. Provide output overvoltage and overcurrent protective devices with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.

E. Mount the 24 vdc power supply such that dissipated heat does not adversely affect other panel components.

F. Provide a Power Supply Diode Redundancy module from the same manufacturer of the power supplies.

F. Manufacturer(s):

1. Phoenix Contact

2. Allen Bradley.

3. Moxa.

4. Or Equal.

2.02 MAIN AND BRANCH CIRCUIT BREAKER

A. General:

1. Circuit breakers shall be furnished and installed in control panels to provide automatically operated switch protection in an electrical circuit from damage caused by an overload or short circuit.

2. Branch circuit breakers shall be approved for branch circuit applications in the United States.

B. Features:

1. Type: High Density Circuit Breaker.

2. Provide Single Pole 120/240V breakers within the control panels.

3. Rating: Provide breakers with proper amp rating to protect the circuit it serves. Normal operating load of each circuit shall be noted on the panel power distribution wiring drawing. Refer to specification Section 13430, Process Control Panels and Enclosures, for internal panel wiring design requirement.

4. Insulation Resistance: 100M-ohm at 500VDC.

5. Terminal Type: Tubular screw with self-lifting box lug.

6. Push-to-set mechanism for circuit actuation.

7. Manual trip button.

8. DIN rail mounted.

9. Status on/off indicator lights

10. Compliance: UL 1077 Listed, CSA C22.2 No. 235, EN/IEC 60934.

11. Compliance: UL 489 Listed

C. Products and Manufacturers: Provide one of the following:

1. Allen Bradley.

2. Or Equal.

2.03 UNINTERRUPTIBLE POWER SYSTEM (SINGLE PHASE)

A. General:

1. Uninterruptible Power System (UPS) shall be furnished to provide a reliable source of uninterruptible power with no break in AC or DC output power during a complete or partial interruption of incoming line power. UPS shall include audio/visual alarms. UPS shall be UL listed.

2. A UPS shall be provided for each control panel.

B. Description: On line dual track power conditioner and true (0 ms transfer time) uninterruptible power supply providing isolation, line regulation and conditioning, using sealed 48 VDC maintenance free batteries and switch mode power supply for uninterrupted power with 0.5 to 0.7 power factor and 2.7 to 3.5 crest factor.

C. Features:

1. Unit shall provide uninterrupted conditioned power, under fully loaded conditions, for 30 minutes. Unit shall be sized to accommodate power requirements for all equipment it is to power for the required length of time and shall provide ten percent spare output capacity at minimum.

2. Rating: 1.4KVA/1.0KW minimum.

3. Lighting and Surge Protection: Inherent 2000: One spike attenuation.

4. Regulation: One to three percent load regulation with less than 2pF effective coupling capacitance for line to load.

5. Output Waveform: Computer grade sine wave with three percent maximum single harmonic and five percent maximum total harmonic distortion.

6. Output Frequency: 60 Hz ±0.5 Hz.

7. Operating Temperature: 1°C to 40°C.

8. Relative Humidity: Five to 90 percent non-condensing.

9. Normally Closed contact output for Battery Low alarm to be connected to a PLC discrete input.

10. Input Protection: Independent battery charger fuse and DC fuses.

11. Output Protection: Inherently current limited ferro-resonant transformer.

12. Battery Charger: Two-step charger, 8 A and 2 A.

13. AC Input: 120VAC, 60Hz, single phase, +15 percent, -20 percent.

14. AC Output: 120VAC, 60Hz, single phase, +3 percent, -3 percent.

D. Products and Manufacturers: Provide one of the following:

1. Eaton.

2. Or Equal.

2.04 SELECTOR SWITCHES, PUSHBUTTONS AND INDICATING LIGHTS

A. General:

1. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.

2. Type:

a. Heavy duty, oil tight.

3. Size:

a. 30.5 mm

3. Provide legend plate for indication of switch, pushbutton or light function (e.g., "OPEN-CLOSED", "HAND-OFF-AUTO").

4. Mounting: Flush mounted on control panel front, unless otherwise noted.

5. NEMA rated to match panel in which mounted.

B. Selector Switches:

1. Type: Provide selector switches with number of positions as required to perform intended functions as shown and specified.

2. Contacts:

a. Provide number and arrangement of contacts as required to perform intended functions specified, but not less than two single pole, double throw contact.

b. Type: Double break, silver contacts with movable contact blade providing scrubbing action.

c. Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts, but not less than 10 A resistive at 120 VAC or DC continuous.

3. Switch Operator: Standard black knob.

C. Pushbuttons (Standard or Illuminated):

1. Type: Provide momentary lighted and/or unlighted, single and/or dual type pushbuttons as required to perform intended functions specified and shown.

2. Contacts: Comply with the requirements specified for selector switches.

D. Indicating Lights:

1. Type: Light-Emitting Diode (LED).

2. Lamps: 2.2 volt, long life (20,000 hours minimum).

E. Button and Lens Colors:

1. See table below

INDICATION	COLOR
Open, On, Running	Red
Closed, Off, Stopped	Green

Equipment Malfunction, Process Trouble and alarms (e.g., "HIGH LEVEL", "LOW LEVEL", etc.)	Amber
Power On	White
Informational (e.g. Backwash, Ready, etc.)	Blue

F. Products and Manufacturers: Provide one of the following:

1. Allen Bradley.
2. Eaton Corp.
3. Or equal.

2.05 DIGITAL INDICATOR

A. General: The digital indicator shall accept an analog input and convert it to scaled numerical characters for digital display and also provide up to two alarm outputs.

B. Required Features:

1. Display Height: 1.2 -inch.
2. Display Capacity: 4½ digits with decimal point position jumper selectable.
3. Display Type: Seven segment, red LED.
4. Accuracy: ± 0.05 percent.
5. Analog Input: 4 to 20 mADC.
6. Excitation Output: 15 VDC for powering transmitter.
7. Analog Output: Proportional 4 to 20 mADC.
8. Temperature Range: 0°C to 60°C.
9. Power: 120 VAC, + 10 to -15 percent.
10. Enclosure: NEMA 4X.

C. Products and Manufacturers: Provide one of the following:

1. Precision Digital.

2. Newport Electronics.

3. Or approved equal.

2.06 CONTROL RELAY

A. Type: General purpose, plug-in type rated for continuous duty.

B. Construction Features:

1. Coil Voltages: 24 VDC or 120 VAC, as required.

2. Contacts: DPDT or 4PDT.

a. Silver cadmium oxide rated not less than 8 A resistive at 120 VAC or 24 VDC continuous.

b. For switching low energy circuits (less than 200 mA) fine silver, gold flashed contacts rated not less than 3 A resistive at 120 VAC or 28 VDC continuous shall be provided.

3. Relays to have clear plastic dust cover.

4. Relays to have pilot light to show energized coil.

5. Relays to be UL recognized.

C. Products and Manufacturers: Provide one of the following:

1. Allen Bradley, 700 Series.

2. Square D Company,

3. Or equal.

2.07 ELECTRONIC HORN

A. General: The horn shall provide an audible warning in the area where a potential alarm may occur.

B. Features:

1. Decibel Output: 100 at 10 feet, minimum.

2. Enclosure Rating: NEMA 4X or NEMA7 in classified areas.

3. Horn Diaphragm: Stainless steel.

4. Power: 120 VAC.

5. Operating Temperature: 32 to120°F.

C. Products and Manufacturers:

1. Federal Signal.

2. Or equal.

2.08 STROBE LIGHT

A. General: Strobe light shall be a pulsating, illuminating type. The light shall provide a visual warning in the area where a potential hazard may occur.

B. Features:

1. Strobe Light: Rotating 360 degrees; 300 effective candlepower, 80 flashes per minute.

2. Lens Color: Amber.

3. Enclosure Rating: NEMA 4X or NEMA7 in classified areas.

4. Power: 120 VAC.

C. Products and Manufacturers:

1. Federal Signal.

2. Or equal.

2.09 ETHERNET SWITCH

A. Ethernet Switches shall have the following features:

1. 10/100 base-TX (auto-sensing).

2. Minimum of five (5) RJ-45 ports.

3. LED for indicating port status.

4. DIN rail mounted.

5. Failsafe output relay to indicate malfunction with unit.

6. FCC Part 15, Class A compliant.

7. Power transformer as required.

8. Provide management software for multilevel security, web based configuration and remote monitoring.

B. Provide Ethernet communication path cable for all required internal panel connections.

C. Product and Manufacturer:

1. RuggedCom.

2. Or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents.

B. All items shall be mounted and anchored in compliance with Section 13430, Process Control Panels and Enclosures.

3.02 START-UP, CALIBRATION, TESTING AND TRAINING

A. Comply with the requirements of Section 13403, Process Control System Start up and Field Testing, and Section 13404, Process Control System Training.

++ END OF SECTION ++

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SECTION 13451

PROGRAMMABLE LOGIC CONTROL SYSTEM
HARDWARE AND SOFTWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for Programmable Automation Controllers (also identified as PAC, PLC or Programmable Logic Controllers) as required for the complete performance of the Work, as shown on the Drawings and as specified herein.

B. All system components specified or shown on the Drawings shall be provided, as well as any ancillary or incidental equipment or devices, whether identified or not, required for a complete functioning system and allow full use of system capabilities.

C. Related Sections: Related sections include, but shall not be limited to, the following:

1. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to Work of this Section.
2. In addition to the requirements specified herein, the requirements of specification Section 13401 Process Control System General Provisions, and the sections referenced therein shall apply to the work of this Section.
3. Process controllers shall include but not be limited to the inputs and outputs listed within specification Section 13480 Input Output Point List
4. Process controllers in conjunction with the Process Instrumentation and Control System shall include but not be limited to the functions specified within specification Section 13491 Process Control Descriptions.
5. Process controller types and configuration requirements are depicted on the Process Instrumentation and Control System drawings.

1.2 REFERENCES

A. General, Publications: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced

publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

1. 2014 Nassau County SCADA Stanards.
2. Canadian Standards Association (CSA)
    a. CSA E61131-2 Programmable Controllers – Part 2: Equipment Requirements and Tests
3. International Automation Association (ISA)
    a. ISA 71.04 Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants
    b. ISA RP 60.11 Crating, Shipping, and Handling for Control Centers
4. International Electrotechnical Commission (IEC)
    a. IEC 60068 Environmental Testing
    b. IEC 60721 Classification of Environmental Conditions
    c. IEC 61000 Electromagnetic Compatibility (EMC)
    d. IEC 61131-2 Programmable Logic Controllers – Part 2 Equipment Requirements and Tests
    e. IEC 61131-3 Programmable Logic Controllers – Part 3 Programming Languages
    f. IEC 61850 Communication Networks and Systems for Power Utility Automation
5. National Fire Protection Agency (NFPA)
    a. NFPA 70 National Electrical Code (NEC)
    b. NFPA 79 Electrical Standard for Industrial Machinery
6. Underwriter Laboratories (UL)
    a. UL 508 – Industrial Control Equipment

1.3 DEFINITIONS

A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.

1.4 SUBMITTALS

A. General: Submittals shall be in accordance with the requirements of Section 01720 Project Record Documents and Section 13401 Process Control System General Provisions, in addition to those specified herein.

1. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly

marked to identify the specific model numbers, options, and features of equipment and work proposed.

2. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

B. Operation & Maintenance (O&M) manuals shall be provided in accordance with the minimum requirements specified in Section 01730 Operation and Maintenance Data, Electrical Requirements and additional requirements specified herein.

C. Training plans shall be provided for all in-person required training. At a minimum this would include the agenda, handouts and listed instructors.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of ten years.

1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.

2. The manufacturer or their representative shall have service, repair, and technical support services available 24 hours 7 days a week basis.

3. The qualified manufacturer shall have within 75 miles of the Project site, a facility or an approved qualified representative capable of providing configuration, installation, startup, training, parts, and coordination of emergency maintenance and repairs.

4. The PLC manufacturer shall have in place a written policy establishing a commitment for product support for an extended period following the initial introduction of the product. The product life cycle policy shall provide for the following support:

   a. All new products will be available on active sale for a minimum of eight years or an equivalent replacement will be supplied.

   b. All products will be supported for a minimum of six years after it has been removed from active sale.

B. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Equipment, assemblies and materials shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.

B. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.

C. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

1.7 WARRANTY

A. General: Refer to 01760 Project Closeout.

B. Additional Owner Rights: The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

C. Warranty: The contractor shall provide a one (1) year warranty for the processors, input/output (I/O) systems, power supplies, racks, and communication interface. The warranty period shall commence on the date of the substantial completion. The terms of the warranty shall provide for replacement of defective components, free of charge, at any time during the warranty period.

1.8 SPECIAL TOOLS AND SPARE PARTS

A. Tools, supplies and spare parts shall be furnished as specified herein for each equipment item.

B. The Contractor shall provide a recommended spare parts list with the following information provided as a minimum:

1. Contact information for the closest parts stocking location to the Owner.
2. Critical spare parts shall be identified as those parts being associated with long lead times and/or those being critical to the unit's operation.
3. Maintenance spares shall be identified as being those parts required to regularly perform scheduled maintenance on the furnished equipment. These spares shall include, but shall not be limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.

C. Spare parts shall be provided for each type and size of unit installed. At a minimum, provide at least one complete set of all plug-in replaceable components of each size and type installed. The following shall be provided:

1. Provide the minimum spare parts recommended by the manufacturer.
2. Provide 5 of each type of power and control fuse installed within equipment
3. Processors: Provide a minimum of two (2) spares for each type of processor unit furnished.
4. PLC Power Supplies: Provide a minimum of two (2) spares for each type of power supply furnished. Provide an additional spare for every ten (10) power supplies of a specific type installed.
5. Input / Output Cards: Provide a minimum of two (2) spares for each type of card furnished. Provide an additional spare for every ten (10) cards of a specific type installed.
6. Communication Modules: Provide a minimum of one (1) spare of each type of module furnished. Provide an additional spare for every ten (10) modules of a specific type installed.
7. Specialty Modules: Provide a minimum of one (1) spare of each type of module furnished. Provide an additional spare for every ten (10) modules of a specific type installed.
8. Chassis: Provide a minimum of one (1) spare of each type of chassis provided.
9. Operator Interface Terminals: a minimum of one (1) spare of each type furnished.

D. Spare parts shall be properly marked and packaged for long term storage. Printed circuit boards shall be provided in separate anti-static containers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Modicon by Schneider Electric. The plant currently has standardized on Schneider Modicon M580 Programmable Logic Controllers.

B. Acceptable Products: Products specified herein shall be the product of a single manufacturer. Products and manufacturers specified are to establish a standard of quality for design, function, materials, and appearance. Products shall be modified as necessary by the manufacturer for compliance with requirements.

C. Single Source Responsibility: Obtain PACs / PLCs and required accessories from a single manufacture with resources to produce products of consistent quality in appearance and physical properties without delaying the work. Any materials which are not produced by the manufacturer shall be acceptable to and approved by the manufacturer. If the PLC manufacturer has authorized third party vendors to provide modules that are compatible with their platforms, then products manufactured by these authorized third-party vendors shall be acceptable.

1. To ensure reliability and compatibility with all aspects of the Process Instrumentation and Control System, all PLC equipment shall be from the same vendor as the Operator Interface Terminals.

D. If process controllers are to be provided from system suppliers other than the Control System Integrator of specification 13451 Section 1.5, the Contractor shall coordinate with the other suppliers to insure that process controllers are of similar brand and type and are equipped to utilize identical communication networks. Existing Ethernet communications are Modbus/TCP.

2.2 GENERAL REQUIREMENTS

A. PLCs shall collect data, perform process control functions and communicate with associated devices (e.g. remote I/O, HMIs, Drives, other PLCs, and/or SCADA servers) as required to exchange process information along the network(s) as specified or shown within the Contract Documents.

B. PLCs shall be modular in design and capable of scalable expansion by adding modules of various functions (e.g. input/output signal modules, power supplies, communication modules, etc.).

C. All PLCs shall be the same manufacturer and of the same series or product line unless specifically shown or specified otherwise within the Contract Documents. Processors, input/output hardware, communications modules, specialty modules, etc. shall be interchangeable among all Process

Instrumentation and Control System control panels and interconnected process systems furnished. Third party PLC modules and hardware by other manufacturers will be acceptable only if the PLC manufacturer does not offer suitable modules and hardware for the same functions.

D. PLC shall have the capability to exchange the CPU reference with another from the same product line series. This exchange must not interfere with the program execution or require firmware or programming updates, i.e. the application must be able to be executed seamlessly regardless of the CPU reference (provided the substitution CPU has sufficient capacity).

E. Be able to have its program downloaded from a remote workstation over a network, or locally programmed from a portable laptop computer.

F. Capacity and Installed Spares:

1. Unless otherwise specified or shown, select the specific PLC model(s) and appurtenances based upon I/O, memory, communication, expansion, and other requirements necessary for the performance of its functions.

2. Each PLC shall include provisions for expansion and shall have 100% spare I/O handling, data, and programming memory capacity of the memory capacity utilized.

3. Each PLC, RIO, or DIO enclosure shall include a minimum of 25% installed spares of each I/O point type provided, minimum of 2 I/O points. Installed spare inputs and outputs shall include all wiring, terminals, surge protection devices, fuses, disconnects, etc. that are provided for process utilized I/O.

4. Each PLC, RIO, or DIO enclosure shall include a minimum of 20% spare rack space and two (2) spare slots for the addition of future I/O modules.

G. Input/Output Signal Arrangement: Unless specifically stated otherwise, THE ORDER AND ARRANGEMENT OF I/O SIGNALS SHALL NOT BE AS SHOWN AS LISTED WITHIN THE CONTRACT DOCUMENTS, BUT SHALL BE ARRANGED TO MINIMIZE FAILURES OF MULTIPLE EQUIPMENT TRAINS DUE TO THE FAILURE OF A SINGLE PLC MODULE.

1. Be modular, field expandable design. The capability shall exist to allow for the expansion of the system by addition of hardware or software.

2. Be able to ‘hot swap’ input/output modules while under power without impacting operation of PLC system or causing destruction of PLC modules, racks, power supplies.

H. Environmental Requirements: PLCs shall meet or exceed the following environmental requirements regardless of the service conditions they are installed in.

1. Minimum temperature range for indoor locations: 0 to +60°C (32 to +140°F)
2. Minimum temperature range for outdoor locations: 0 to +60°C (32 to +140°F)
3. Extended temperature range for outdoor locations (–25 to +70°C) or (-13 to +158°F)
4. Relative humidity:30 to 95% non-condensing.
5. Operation at Altitudes: 0-6,500 feet minimum
6. Degree of protection: NEMA 1 (IP20)
7. Vibration resistance in accordance with at least one of the following:
    a. Installed rating:
        1) DIN rail mounted PLC: 10-57 Hz, amplitude 0.075 mm, acceleration 25-100 Hz, and
        2) Panel or plate mounted PLC: 2-25 Hz, amplitude 1.6mm, acceleration 25-200 Hz.
    b. In compliance with IEC 60068 and IEC 61131.
8. Shock resistance: 147m/s2 for 11ms.

2.3 PROGRAMMABLE AUTOMATION CONTROLLER – LARGE TYPE – REDUNDANT (PLC-ABF)

A. Basis-of-Design: Subject to compliance with requirements, the basis of design for this product is the Modicon M580 Programmable Automation Controller by Schneider Electric. The plant currently has standardized on Schneider Modicon M580 Programmable Logic Controllers.

B. Description: A chassis mount PLC designed for up to 6144 discrete points and 1536 analog points. Additional I/O will be interfaced to the PLC via remote I/O or distributed I/O.

C. Executive firmware shall be updated in the field using standard programming tools. Executive firmware files shall be readily available via a public web site. The firmware download shall be performed by connecting to either of the following:
1. The CPU USB connector
2. The CPU Service Port
3. The Ethernet network

D. The PLC shall utilize Ethernet protocols that meet the following:
1. Protocols that are assigned to port 502 of the TCP/IP stack by the IANA (Internet Assigned Numbers Authority). Modbus/TCP

2. DNP3 IEC-60870-6 via Native Communication Card
3. Will not rely on third party vendors to meet the above criteria.

E. Central Processors:

1. The processor shall be:
    a. Open architecture with direct Ethernet connection on the backplane allowing transparent access to data
    b. Simple and flexible
    c. Able to change configuration on the fly without stopping the process
    d. Able to add or remove I/O modules on local or Remote IO drop without stopping the process
    e. Modify channel configuration parameters
    f. Automatic reconfiguration of modules on hotswap
    g. Online application changes during runtime including adding new variables shared with HMI (Human-Machine Interfaces).
    h. Able to mix remote I/O and distributed equipment and other devices on the same Ethernet field network with complete software integration
    i. Capable to access and manage HART I/O data
    j. Natively deterministic
    k. Flexible in architecture design through fiber or wireless connections through the embedded in-rack converter modules.
    l. Cyber security ready with Achilles Level 2 certification and advanced built-in cyber security feature as defined by standard IEC 62443
2. The Processor shall have:
    a. A USB terminal port for programming.
    b. An RJ45 Ethernet port that allows diagnostic of Ethernet ports and provides access to external tools, devices and distributed I/O devices.
    c. Dual RJ45 Ethernet ports for connection to the remote I/O drops (EIO) and distributed equipment (DIO) through dual redundant switches (DRS). The 2 device network ports will support a wired star or ring architecture (daisy chain loop). Dual Ethernet ports will support RSTP to enable all remote I/O devices located on the ring to recover from a communication disruption within 50 ms.
    d. An embedded web server for web access. Additional modules for this function will not be accepted.
    e. An embedded remote I/O scanner service allowing scanning of remote I/O drops (X80 I/O) and distributed I/O.
    f. The PLC shall have a configurable alarming capability. Each alarm point can be configured to display an alphanumeric message in the

alarm buffer. The buffer can be displayed via a web page, or on an operator interface screen

g. A 4GB SD memory card. This card shall be capable of storing, at a minimum application files, data files, PDF files, CAD files, Microsoft office files.

h. On board status lights to indicate the following various functions:

1) Green RUN lamp that will illuminate while program is executing.

2) RED ERR lamp that will illuminate while program is executing

3) Red I/O lamp that will illuminate upon an I/O failure or configuration fault.

4) Green DL lamp that will illuminate while the firmware download is in progress

5) Red BACKUP lamp that will illuminate on memory backup

6) Green/Red ETH MS lamp will indicate the Ethernet port configuration status

7) Green/Red ETH NS lamp will indicate the Ethernet connection status

3. Acceptable processors are detailed below:

a. Model # BMEH582040 - [8 MB of internal user RAM, capable of supporting up to 4 local racks, and 128 distributed I/O devices. Capable of handling 8,192 Discrete I/O and 2,048 Analog I/O. Processor performance shall be rated at least 7,500 instructions per millisecond at a program make up of 65% Boolean and 35% numerical]. Processor must support Hot-Swap redundancy and ring-topology Ethernet Remote I/O without additional communications cards.

b. Or equal.

4. Upon power loss, the PLC shall insure memory is transferred to flash memory before PLC RAM powers down. PLCs with a battery backup will not be accepted.

F. High Availability

1. The Processor must at least include a processor designed to be part of a redundant architecture, obeying a principle of redundant controllers which guarantees a switchover without loss of control of the process on occurrence of a failure

2. The implementation of the redundant solution shall be "plug & play" by design.

3. The data exchanges between the two redundant processors (Primary and Standby), are using a high speed link of 1 Gbps.

4. The redundant system must be seen by the SCADA as a single PLC (one IP address). The system manages in all transparency and automatically the IP address swapping of the Ethernet couplers.
5. The redundant controllers have their own IP addresses that never swap, to connect the engineering tool continuously.
6. The system components internal firmware can be updated while the system is running without losing the redundancy function.
7. The redundant power supplies must provide a transparent status of their redundancy without extra hardware or wiring and are required to be mounted in local or remote backplanes.
8. The redundant power supplies must provide natively information about their ageing, to be able to be replaced before failure (preventive maintenance.)
9. The redundant power supplies must use a true redundant technology (one active at a time, the other ready to take full load if needed), not using load sharing technology.

G. Ethernet Remote I/O (RIO)

1. The PAC shall be capable of communicating to Remote I/O and shall be capable of being configured in both linear 'daisy-chain' or self-healing ring topologies.
2. The Remote I/O adapter module will consist of a dual Ethernet ports, labeled as "Device Network", and a service port. Two Ethernet ports are used for linking the head and the drops together.
3. The RIO system is based on Ethernet technology supporting Ring Topology.
4. The Remote I/O adapter will support Time Stamping at 10 ms

H. Distributed I/O

1. The PLC platform can also be used as I/O for Distributed I/O applications. The system will have a Distributed I/O Interface Module. This processor can be used to store logic that would be executed on a loss of communication, or limited independent logic.

I. Specialized I/O Cards: The PLC shall have a series of application specific I/O cards. These will be as follows:
   a. High speed counter card: Eight (8) channels at 10 KHz, 16 bits. Two (2) inputs at 24VDC per channel. The card shall also be capable of handling four (4) incremental encoders in 32 bit.
   b. High performance high speed counter card: 2 channels at 60 KHz at 32 bits. Six (6) inputs at 24VDC and Two (2) reflex outputs per channel.

c. Eight (8) channels input HART module

d. Four (4) channels output HART module

J. Communication Capabilities: The PLC shall support the following without the need for third party modules

1. ASi V3 Master
2. Serial protocols including Modbus, Unitelway, and ASCII.
3. DNP3
4. CANopen
5. The PLC shall offer an Ethernet card with Three (3) ports. Each port shall be capable of communicating both Modbus TCP, and Ethernet I/P simultaneously. Cards requiring that the port be configured for one protocol will not be accepted. The card shall support the following functions:
   a. Ring topologies using RSTP (Rapid Spanning Tree Protocol)
   b. Priority of Ethernet packets using QoS (Quality of Service)
   c. Automatic module configuration recovery using FDR (Fast Device Replacement)
   d. Embedded Web Server for application monitoring and module diagnostic. Additional modules for this function will not be accepted.
   e. Sharing data between PACs
   f. Network management using SNMP (Simple Network Management Protocol)

K. Power Supplies: The PLC shall have chassis mounted power supplies to provide power for the processor and applicable modules. The power supplies shall be available in both 24 VDC and 115 VAC models. The available power ratings will be from 16 to 36W.

L. Ethernet backplanes: The chassis shall come in 4, 8, and 12 position configurations. The cards will be secured to the chassis via a screw connection.

2.4 PROGRAMMABLE AUTOMATION CONTROLLER – SMALL TYPE – NON-REDUNDANT (LOCAL CONTROL STATIONS BLW-LCP 1, 2, 3, 4 5 AND PLC-HVAC-ABF)

A. Basis-of-Design: Subject to compliance with requirements, the basis of design for this product is the Modicon M580 Programmable Automation Controller by Schneider Electric.

B. Description: A chassis mount PLC designed for up to 1024 discrete points and 256 analog points. Additional I/O will be interfaced to the PLC via distributed I/O.

C. Executive firmware shall be stored in Flash memory and can be updated in the field using standard programming tools. Executive firmware files shall be readily available via a public web site.

D. Small PLCs shall utilize Ethernet protocols that meet the following:
   1. Protocols that are assigned to port 502 of the TCP/IP stack by the IANA (Internet Assigned Numbers Authority).
   2. Protocols that are supported by the Open DeviceNet Vendors Association (ODVA)
   3. Will not rely on third party vendors to meet the above criteria.

E. Processors:
   1. The processor shall be:
      a. Open architecture with direct Ethernet connection on the backplane allowing transparent access to data
      b. Simple and flexible
      c. Able to change configuration on the fly without stopping the process
      d. Able to add or remove I/O modules on local or Remote IO drop without stopping the process
      e. Modify channel configuration parameters
      f. Automatic reconfiguration of modules on hotswap
      g. Online application changes during runtime including adding new variables shared with HMI (Human-Machine Interfaces).
      h. Able to mix remote I/O and distributed equipment and other devices on the same Ethernet field network with complete software integration
      i. Capable to access and manage HART I/O data
      j. Natively deterministic
      k. Flexible in architecture design through fiber or wireless connections through the embedded in-rack converter modules.
      l. Cyber security ready with Achilles Level 2 certification and advanced built-in cyber security feature as defined by standard IEC 62443
   2. The Processor shall have:
      a. A USB terminal port for programming.
      b. An RJ45 Ethernet port that allows diagnostic of Ethernet ports and provides access to external tools, devices and distributed I/O devices.
      c. Dual RJ45 Ethernet ports for connection to the remote I/O drops (EIO) and distributed equipment (DIO) through dual redundant switches (DRS). The 2 device network ports will support a wired star or ring architecture (daisy chain loop). Dual Ethernet ports will

support RSTP to enable all remote I/O devices located on the ring to recover from a communication disruption within 50 ms.

d. An embedded web server for web access. Additional modules for this function will not be accepted.

e. An embedded remote I/O scanner service allowing scanning of remote I/O drops (X80 I/O) and distributed I/O.

f. The PLC shall have a configurable alarming capability. Each alarm point can be configured to display an alphanumeric message in the alarm buffer. The buffer can be displayed via a web page, or on an operator interface screen

g. A 4GB SD memory card. This card shall be capable of storing, at a minimum application files, data files, PDF files, CAD files, Microsoft office files.

h. On board status lights to indicate the following various functions:

1) Green RUN lamp that will illuminate while program is executing.

2) RED ERR lamp that will illuminate while program is executing

3) Red I/O lamp that will illuminate upon an I/O failure or configuration fault.

4) Green DL lamp that will illuminate while the firmware download is in progress

5) Red BACKUP lamp that will illuminate on memory backup

6) Green/Red ETH MS lamp will indicate the Ethernet port configuration status

7) Green/Red ETH NS lamp will indicate the Ethernet connection status

3. Acceptable processors are detailed below:

a. Model # BMEP582040 - 8 MB of internal user RAM, capable of supporting up to 4 local racks, and 128 distributed I/O devices. Capable of handling 8,192 Discrete I/O and 2,048 Analog I/O. Processor performance shall be rated at least 7,500 instructions per millisecond at a program make up of 65% Boolean and 35% numerical. Processor must support ring-topology Ethernet Remote I/O without additional communications cards.

b. Or equal.

4. Upon power loss, the PLC shall insure memory is transferred to flash memory before PLC RAM powers down. PLCs with a battery backup will not be accepted.

F. Specialized I/O Cards: PLCs shall have a series of application specific I/O cards. These will be as follows:

a. High speed counter card: Eight (8) channels at 10 KHz, 16 bits. Two (2) inputs at 24VDC per channel. The card shall also be capable of handling four (4) incremental encoders in 32 bit.
b. High performance high speed counter card: 2 channels at 60 KHz at 32 bits. Six (6) inputs at 24VDC and Two (2) reflex outputs per channel.
c. Eight (8) channels input HART module
d. Four (4) channels output HART module

G. Communication Capabilities: PLCs shall support the following without the need for third party modules

1. 10/100 MB Ethernet with Fast Device Replacement (FDR) capability, Ethernet scanner capabilities (64 devices per card), Global Data, Network Time Protocol support, standard web page and custom web page capability. A memory card will be available to store web pages and data.
2. ASi V2 Master
3. Serial protocols including Modbus, Unitelway, and ASCII.
4. DNP3
5. CANopen
6. The PLC shall have an Ethernet card with four (4) ports. Each port shall be capable of communicating both Modbus TCP, and Ethernet I/P simultaneously. Cards requiring that the port be configured for one protocol will not be accepted. The card will also support the following functions:
   a. Ring topologies using RSTP (Rapid Spanning Tree Protocol)
   b. Priority of Ethernet packets using QoS (Quality of Service) service
   c. Automatic module configuration recovery using FDR (Fast Device Replacement)
   d. Embedded Web Server for application monitoring and module diagnostic
   e. Sharing data between PACs
   f. Network management using SNMP (Simple Network Management Protocol)

H. Power Supplies: PLCs shall have chassis mounted power supplies to provide power for the processor and applicable modules. The power supplies shall be available in both 24 VDC and 115 VAC models. The available power ratings will be from 16 to 36W.

I. Chassis: The chassis shall come in 4, 6, 8, and 12 position configurations. The cards will be secured to the chassis via a screw connection.

2.5 INPUT / OUTPUT AND SPECIALIZED MODULES

A. Input/output hardware shall be supplied in standard modules of 4, 8, 16, 32 or 64 each for assembly in local and/or remote (M580 only) input/output enclosures

B. All input/output hardware shall be entirely contained within PLC enclosure.

C. All I/O modules will be hot swappable while the PLC is running

D. Each discrete point shall have a light emitting diode to indicate point status. Green shall indicate that the point is logic level "1", also referred to as "on" or "high".

E. The I/O cards will be as follows:

1. Discrete Inputs:
    a. Model # BMXDDI1602 – Sixteen (16) channel 24VDC input cards
    b. Or Equal
2. Discrete Outputs:
    a. Model # BMXDDO1602 – Sixteen (16) channel 24VDC/240VAC relay output card
    b. Or Equal
3. Analog Inputs: All Analog input cards will offer isolation between channels.
    a. Model # BMXAMI0810 – Eight (8) channel, 0-20mA, 16 bit resolution isolated
    b. Or Equal
4. Analog Outputs: All analog output cards will offer isolation between channels,
    a. Model # BMXAMO0410 – Four (4) channel, 0-20mA output card, 15 bit resolution
    b. Or Equal

F. Communications Card – Each Processor Rack shall have a communication module to communicate to the plant SCADA system.

1. Model # BMENOC0301 – Modbus/TCP Communications Card
2. Or Equal

G. Ethernet Remote I/O drop adapter:

1. Model # BMECRA31210 – Minimum of 3 I/O ring RJ45 ports and 1 Service RJ45 port.

2. Or equal

H. Power Supply – Rack Based

1. Model # BMXCPS3500 – 120VAC Modicon Power Supply
2. Or Equal

I. PLC CPU Backplate

1. Model # BMEXCP0400 – 8 Slot Chassis
2. Or Equal

J. Remote I/O Drop Backplate

1. Model # BMXXBP1200 – 12 Slot Ethernet Chassis
2. Or Equal

2.6 COMMUNICATIONS

A. Each Programmable automation controller shall be furnished complete with communication hardware modules for local input/output, other programmable controllers and for host computers.

1. Each PLC shall communicate to the host computer over Ethernet communications network.
2. PLC-to-PLC communication protocol shall be Ethernet based. System supplier shall include all rack mounted or enclosure mounted communications modules required for a complete working system.

B. Web Services:

1. Description: PLCs shall provide a standard web server with pre-configured and customizable web pages. Pre-configured web pages shall display all internal status points, status registers, alarm words, and status of each I/O point. Additional modules for this function will not be accepted.
2. Customizable web pages shall be created by the programmer to display the actual process or machine being operated
3. PLCs shall be capable of:
    a. Modbus TCP messaging: The web services shall use Modbus TCP messaging over port 502 of the TCP packet.
    b. Capable of Fast Device Replacement (FDR): PLCs shall act as a fast device replacement client/server. This will enable PLCs to automatically download the IP address and configuration file to FDR client devices.

c. Capable of network management using SNMP (Simple Network Management Protocol).

d. Capable of Time synchronization service: PLCs shall be capable of synchronizing from its internal clock from a clock on a NTP server.

e. I/O scanning service: I/O scanning will allow the PLC to exchange data to/from remote devices on the network.

f. Capable of Global Data: PLCs shall use Global Data service to ensure real time communication between stations in the same distribution group while minimizing network loading. Global Data servicing will use Real-Time Publisher Subscriber producer consumer based protocol.

g. PLCs web services shall be compatible with other devices. This includes power equipment, HMIs, Switches, and VFDs.

h. Bandwidth monitoring service: PLCs shall be capable of monitoring the bandwidth to determine load level.

2.7 PLC PROGRAMMMING HARDWARE - LAPTOP

A. The programming device shall be a portable notebook computer. System supplier shall provide two interconnecting cables, each 5 meters long, to connect the computer to the programmable automation controller. The cables shall be shielded and shall be terminated on both ends with the appropriate connectors.

B. QTY one (1) Windows based laptop including:

1. Windows 11 Pro operating system pre-installed
2. Core 2 Duo processor or greater
3. 16GB minimum RAM
4. 256GB minimum Solid State Hard Drive
5. 15” or larger screen
6. Dell or approved manufacturer.

C. PLCs shall utilize a USB to USB cable for programming. This cable shall be compatible with those designed for downloading digital cameras to USB compatible PC. Accordingly, this cable shall be available through most traditional retail stores serving the consumer electronics market.

D. PLC programming software should be installed with the appropriate license on the laptop.

2.8 PLC PROGRAMMMING SOFTWARE

A. All specified PLC platforms will be programmed using the same programming software package. PLCs that use multiple software programming packages under similar trade names will not be accepted.

B. The programming software will support five IEC61131-3 languages: Instruction List (IL), Structured Text (ST), Ladder Diagram (FD), Function Block Diagram (FDB) and Sequential Function Chart (SFC) and User Derived Function blocks (DFB).

C. The system shall be designed to execute all languages without a significant decrease in processing speed.

D. Programming software shall have:

1. Embedded PLC simulator for debugging and program validation.
2. Embedded network configuration tools that utilize FDT/DTM technologies. PLC's that use separate programming, communication, simulation and network configuration software shall not be accepted.

E. Schneider EcoStruxure Control Expert or equal.

2.9 PLC PROGRAMMMING AND CONFIGURATION

A. Application process controller programming and configuration requirements are specified within specification Section 13491 Process Control Descriptions

2.10 OPERATOR INTERFACE TERMINAL (OIT)

A. Provide a programmable Operator Interface Terminal (OIT to enable Operator control and monitor field equipment. The OIT unit shall be flush panel mounted on the front of the panel. OIT unit shall be provided with all necessary hardware, cables and software to accomplish the interface as specified herein and shown on the Contract Drawings.

B. Performance Requirements:

1. The OIT shall be designed to display directly connected to the remote I/O service port or PLC Ethernet network and shall be able to transfer up to twenty-two 64 word blocks each way.
2. The OIT shall be provided with off-line development software which allows development of graphic picture files, touch screen key files, alarm files, trend files, system configurations, variables and screen definitions. Provision shall be made to store commonly used symbols and screen definitions.

3. The OIT shall support and be programmed to match the existing security requirements utilized by Nassau County, including but not limited to Username/Passwords for access levels. Supplier must coordinate on security access levels.

C. Each OIT shall be provided with the following minimum requirements:

1. Display: 15-inch Color TFT LCD 1366x758 pixels, 16 million color Single Touch touchscreen.
2. Memory: 1GB Device Memory, 512kb backup memory, 128MB user data memory.
3. Communication: Two (2) RJ45 Ethernet Ports, 1 COM Serial Port, USB Programming port.
4. Input Voltage: 24VDC +-20%
5. Power Consumption: 22 Watts (maximum)
6. Operating Temperature: 0-50 degrees Celcius.
7. Humidity: 10 – 90% without condensation.
8. Rating: NEMA4/IP65 front of panel

D. Manufacturers:

1. Provide operator interface terminals (OIT) of the same manufacturer as the PLC hardware provided and matching the type in-use by the lant. The OIT shall be one of the following:
    a. Harmony ST6 Model # HMIST6700, by Schneider-Electric
    b. Or approved equal.

E. Software:

1. Operator Interface Terminal shall be pre-packaged with all configuration and programming software necessary to perform functions as shown on drawings and within the specifications.
2. Integrated OIT software shall have the following features configured to apply to this project.
    a. Trending.
    b. Data Logging.
    c. Alarms.
    d. Graphic Symbols.
    e. Animations.

F. I/O Ports and Devices:

1. OIT shall have a minimum of two Ethernet 10/100 Mbps for connectivity or programming.
2. OIT shall have a minimum of one Serial RS232 port.
3. OIT shall have a minimum of one USB port with a supplied USB memory stick.

G. Display

1. Screens: 15-inch Color TFT LCD 1366x758 pixels minimum.
2. Display shall support touch screen input.

H. Programming Software:

1. The current software the manufacturer utilizes for programming the software must be purchased to turn over to the owner.
2. The programming software and license are to be installed on the same laptop as the PLC programming software.
3. Manufacturer Part:
    a. Model # EcoStruxure Operator Terminal Expert by Schneider
    b. Or Equal – Must match supplied OIT

I. Screens:

1. Contractor shall be responsible for updating/modifying the existing GE Cimplicity based SCADA system to include all new screens and new I/O points added or modified under this project. Modifications also pertain to the GE Historian software for all new points to be monitored and existing points to be modified.
2. Dedicated OIT screens shall be provided for the following:
    a. All major process equipment with a separate overview screen for each process type. Overview screen shall display color object-oriented graphics which represent the process and provide the operator the ability to view, monitor, control and adjust set-points for the various equipment involved in the process. Real-time values being read from the field devices shall be displayed in a variety of user-configurable formats. Required process overview screens include but are not limited to:
        1) Aeration blower screens.
            a) Aeration blowers overview.
            b) Individual blower screen.
        2) Aeration Tanks:
            a) Aeration tanks overview.

b) Individual Aeration tanks screen.

3) HVAC System overview.

4) Power Monitoring Overview.

5) Alarm screens

6) Trending for all analogs.

7) User Log-In pop-up.

3. Contractor shall follow Nassau County Standards for screen design. This includes but not limited to colors, functionality, security requirements and navigation. Screens should match the look and feel of existing plant screens.

4. All process variables must be trended. Dynamic trend displays shall plot at least eight (8) user selectable analog values.

   a. Aeration Tanks shall have individual trend screens per tank.

   b. Each blower should shall have all analog values and alarms trended on a per-blower screen.

   c. All trends shall be capable of exportation onto an external USB via data-file in .csv format.

5. All alarms shall be annunciated on the screen through the alarm screen/banner and be logged with the ability to be recalled on the Alarm History screen.

   a. All Data point and Alarm tags shall conform to the Nassau County SCADA standards.

6. Security:

   a. Security levels based on Nassau County SCADA standards and matching existing plant security utilized on existing OIT/HMI screens.

   b. All OITs to be programmed to time-out to a read-only display. Proper user login required to make process changes.

2.11 IDENTIFICATION

A. Each process controller I/O point shall have its service description and / or tag identified and typeface labeled at the termination point on the I/O module. Where available space prohibits a meaningful identifier to be provided at the termination point, the point shall be numbered at the termination interface and a cross reference listing of I/O tags, service descriptions, module location, and point number shall be provided adhered to or laminated and placed within the control panels interior at the approval of the Engineer. This cross reference shall

be a draft copy until after onsite demonstration testing when it shall be finalized and installed within the panel.

2.12 PLC ENCLOSURES

1. Each PLC and its corresponding I/O modules, power supplies, communication modules, peripheral equipment and UPS shall be mounted inside suitable enclosures. All I/O writing from the field to the I/O modules shall be terminated on terminal blocks in the enclosures.
2. Additional PLC enclosures requirements are specified within specification Section 13430 Process Control Panel and Enclosures.

2.13 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Each Control Enclosure with a PLC shall be provided with UPS backup power. The UPS shall be sized for a minimum 30 minute minimum power backup time. Sizing shall include the following loads as a minimum:

1. All PLC enclosure loads excluding lights, heaters and utility receptacles, but including external instrumentation powered from the control panel.

B. Additional PLC UPS requirements are specified within specification Section 13440 Panel Mounted Instruments & Devices.

C. Each workstation shall be provided with UPS backup power. The UPS shall be sized for a minimum 15 minute minimum power backup time. Sizing shall include the following loads as a minimum:

1. Work station.
2. Monitors.
3. External Hard Drives utilizing external power.

2.14 SCADA WORKSTATION - ULISCADABPWS08

A. General:

1. A SCADA workstation is to be provided to connect to the existing GE Cimplicity Servers located in the plant Network Room via the plant fiber optic ring.
2. The SCADA workstation is to run as a client.
3. The SCADA workstation screens shall duplicate all the OIT screens for the Aeration System along with other equipment specified herein.
4. The SCADA servers are to be updated for all of the new screens and input/output points as specified herein.

5. The SCADA workstation screens shall follow the same “Look and Feel” as the existing SCADA screens and follow the Nassau County SCADA Standards.
6. The SCADA workstation shall follow the existing security scheme as utilized throughout the plant.

B. A workstation shall be provided for connection to the existing plant SCADA.
1. Dell Intel core Duo 3.0Ghz or better processor.
2. 8GB of RAM minimum.
3. 256GB Solid State hard drive minimum.
4. One (1) Monitor 20-inch Color TFT LCD 1366x758 pixels, 16 million color. Existing SCADA screens are designed for 1366x758 pixels.

C. Workstation Software:
1. GE Cimplicity v11 SCADA Client – No Equal
2. Anti-Virus Software. Webroot or Equal.
3. Windows 11 Pro or as advised by GE for the version of the software to be installed.

D. Desk:
1. A desk shall be provided to house the SCADA workstation, UPS and related items.
   a. Width: 42” width minimum.
   b. Height: Adjustable 26”-30” minimum.
   c. Frame: Painted Steel, Black.
   d. Top: Plastic Laminate.
   e. Capacity: 350Lbs
2. Manufacturers:
   a. Global Industrial.
   b. Safco.
   c. Or Equal.

PART 3 - EXECUTION

3.1 GENERAL

A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Section 13401 and Drawings.

B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.

C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

D. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

E. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.

F. Functional testing, commissioning, and first parameter adjusting shall be carried out by a factory trained manufacturer's representative field service engineer. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment. Report to the Engineer any discrepancies or issues with the installation.

G. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

3.2 FACTORY ACCEPTANCE TESTING

A. Factory Acceptance Testing shall be witnessed by the Engineer and Owner. The testing demonstration shall include but not limited to the following:

1. Review of drawings for the purchased equipment to be done with the manufacturer's application engineer.

2. The complete PLC system as shown on the system architecture drawing shall be assembled and interconnected on the factory floor. The interconnection shall include communication cable segments and the workstation network or SCADA host to simulate the site installation. The PLC, PLC programming, workstations and communication devices shall be loaded with their applicable software packages and configuration

programming. PLC input and output modules shall be installed in their assigned enclosures and wired to field termination points.

3. The test procedures shall include written descriptions on how tests shall be performed and shall incorporate the following features:
   a. I/O points: Verification of all points on each display screen
   b. Alarms: Verification that alarms are generated
   c. Control Setpoints: Ability to change setpoints or to adjust control parameters with the proper security levels.
   d. Power failure.
   e. CPU failure.
   f. Trends.
4. Components shall be verified against drawings to be present and correctly installed.
5. Demonstration of the functionality and performance of specified features of the PLC.
6. Verification of all PLCs, remote I/O system, I/O point status, display screens and communications. A complete checklist shall be available during the test for recording results of selected points.]

3.3 TRAINING

A. The contractor shall provide training for the purpose of familiarizing the Owner's maintenance and operating with the use, maintenance and repair of all components of the PLCs. The training sessions shall be designed for maintenance and operations personnel with training that is specific to the system installed at the Owner's facility. At a minimum, the training shall cover the following topics:

1. PLC System Hardware – General Familiarity – 8 Hours
2. PLC Programming Software – General Familiarity – 4 Hours
3. PLC Programming Software – Advanced – 4 Hours
4. OIT Programming Software – General Familiarity – 4 Hours
5. Troubleshooting – 4 Hours
6. Replacement of components – 2 Hours

++ END OF SECTION ++

SECTION 13461

CONTROL AND DATA EQUIPMENT

PART 1 – GENERAL

1.1 PCS SCOPE OF WORK

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up and place in satisfactory an Ethernet based network system for operation of a complete Process Control System (PCS).
   2. The Networking Work includes, but is not limited to, the following:
      a. Supply of a new network rack (FOCE-ABF) containing the main networking equipment.
      b. Tie-In of the new FOCE-ABF to the existing plant Fiber-Optic ring including the use of the Rapid Spanning Tree Protocol (RSTP) or other similar protocol in-use by the plant Fiber-Optic ring.
      c. Configuration of the new network switches and related equipment along with modifications as required to all existing plant Fiber-Optic ring network equipment.
      d. Coordination with the owner on V-Lan and IP assignments and updating all Purdue Model Networking documentation including spreadsheet formats and drawings.
      d. Field testing of the network modifications and new networking equipment.
      e. Coordination with equipment manufacturers for Tie-In to the plant network.
      f. Furnish all necessary cables, face plates, fiber SFP connectors, repeater modules, splice kits, etc required for a complete and operational network. The system architecture diagrams(s) are for network understanding only. Some additional communication devices may be required for network operation, which may not be explicitly shown on the Drawings.
      g. Update the existing SCADA system to monitor the UPS units in the FOCE-ABF via the Ethernet connection and revise the GE Cimplicity SCADA screens to monitor the new networking equipment in the FOCE-ABF to match the existing plant FOCE monitoring.

B. In addition to the general requirements, provide a Method of Plant Outage for modifications to the existing SCADA network to ensure minimal downtime. All downtime of the network must be coordinate with the owner along with any systems that may be affected.

C. The Contract Documents describe the required PCS and PCS functions and operational requirements.

D. Coordination:
   1. Networking design:
      a. Networking system and related components are part of the Work by instrumentation and controls (I&C) Supplier. Programming of Ethernet switches is part of the Work. The I&C Supplier's network engineer shall program and configure the switches to function as required to interact with other network switches, SCADA servers and industrial devices.
   2. To centralize responsibility, networking materials and equipment provided under this Contact shall be furnished by a single Supplier.
   3. With Contractor, I&C Supplier shall assume the responsibility for adequacy and performance of materials and equipment provided under this Section.
   4. To the greatest extent possible, provide networking materials and equipment from a single manufacturer.
   5. Supplier's Responsibilities:
      a. Preparing all network equipment submittals in accordance with the Contract Documents.
      b. Proper interfacing of network equipment with field equipment, instruments, devices, and panels, including required interfacing with packaged control systems furnished by other equipment Suppliers, and required interfacing with the Site's electrical system.
      c. Review and coordination with manufacturers, other Suppliers, and other contracts of Shop Drawings and other Contractor submittals for network cabling and power cabling.
      d. Direct, detailed oversight of installation of network cabinets, wiring and other components, and related wiring and piping connections.
      e. Calibrating, source quality control, field quality control, and start-up of the system.
      f. Responsibility for correction period obligations for the PCS.
      g. Training operations and maintenance personnel in operation and maintenance (including calibration and troubleshooting) of the PCS.

F. Related Sections:
   1. Section 13491, Process Control Descriptions.
   2. Section 13461-2.6, Fiber Optic Cables and Connectors
   3. Refer to the drawing package for network architecture drawings, cable and conduit routing and equipment locations.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/ASQ Z1.4, Sampling Procedures and Tables For Inspection By Attributes.
2. ASTM A269, Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
3. ASTM A312, Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
4. ASTM A403, Specification for Wrought Austenitic Stainless Steel Piping Fittings.
7. IEEE 802.1X, Port Based Network Access Control.
8. IEEE 802.3, Standards Defining Physical Layer and Data Link Layer Media Access Control (MAC) Sublayer of Wired Ethernet
9. ISA 5.1, Instrumentation Symbols and Identification.
10. ISA 5.4, Instrument Loop Diagrams.
11. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
12. NFPA 70 (NEC), Article 770, Optical Fiber Cables and Raceways.
13. NFPA 79, Electrical Standard for Industrial Machinery.
14. UL 50, Safety Enclosures for Electrical Equipment, Non-Environmental Considerations.
15. UL 508A, Industrial Control Panels.
16. ISO/IEC 11801
17. 2014 Nassau County SCADA Standards.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. I&C Supplier:
      a. Shall be financially sound with at least five years of continuous experience in designing, implementing, supplying, and supporting networking systems for municipal wastewater treatment facilities comparable to PCS required for the Project, relative to hardware, software, cost, and complexity.
      b. Shall have record of successful process control system equipment installations. Upon Engineer's request, submit record of experience for at least five projects, each with the following information: project name, owner name and contact information, name and contact information for contractor, name and contact information for engineer or architect, approximate and contract value of process control systems Work for which Supplier was responsible.
      c. Shall have at time of Bid experienced engineering and technical staff capable of designing, supplying, implementing, and supporting the instrument and control system and complying with submittal and training requirements of the Contract Documents.

d. Shall be capable of training operations and maintenance personnel in network applications, and in operating, programming, and maintaining the Ethernet network.
e. Shall have UL-approved panel shop.
f. Possess a thorough, working knowledge of wastewater treatment processes and control philosophy in accordance with standard practices of the wastewater treatment industry.
g. Possess and maintain a documented program of failure analysis.

2. Manufacturers:
   a. Manufacturers of instrumentation and control equipment furnished for the PCS shall be experienced producing similar equipment and shall have the following qualifications:
      1) Shall manufacture instrumentation and control system components that are fully-developed, field-proven, and of standardized designs.
      2) Shall have system of traceability of manufactured unit through production and testing in accordance with ANSI/ASQ Z1.4.
      3) Shall have guaranteed availability clause (99.99 percent, minimum for one year) for microprocessor-based components and appurtenances.
      4) Shall have documented product safety policy relevant to materials and equipment proposed for the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Network Cabinets:
         1) Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
         2) Network layout drawings that include:
            a) Front, rear, and internal panel views to scale.
            b) Tag number and functional name of components mounted in and on panel, console, or cabinet, as applicable.
            c) Product information on panel components.
            d) Nameplate location and legend including text, letter size and colors to be used.
            e) Location of anchorage connections.
            f) Location of external wiring and piping connections.
            g) Mounting and installation details, coordinated with actual application.
            h) Wire connections including terminal information.

i) System Architecture Diagram showing in schematic form all interconnections between major hardware components utilizing Ethernet. All power wiring and devices feeding Ethernet devices.
j) System Architecture Diagram changes to existing plant networks modified under this contract.

2) Product information on panel components including:
a) Manufacturer's product name and complete model number of devices being provided, including manufacturer's name and address.
b) Instrument tag number in accordance with the Contract Documents.
c) Data sheets and catalog literature. Submit data sheets as shown in ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets with format similar to ISA 20.
d) Description of construction features.
e) Performance and operation data.
f) Installation, mounting, and calibration details; instructions and recommendations.
g) Service requirements

C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data:
a. Submit in accordance with Section 01730, Operation and Maintenance Data.
b. Include complete up-to-date system software documentation. Provide hardcopy and electronic copies.
c. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.
2. Record Documentation:
a. Prepare and submit record documents in accordance with Section 01720, Project Record Documents.
b. Revise all system Shop Drawing submittals to reflect as-built conditions in accordance with the following.
1) Two copies of each revised Shop Drawings and documentation to replace out-dated drawings and documentation contained in operation and maintenance manuals. Submit half-size black line drawings for each drawing larger than 11 inches by 17 inches. Include specific instructions for out-dated drawing removal and replacement with record documents submittal.
2) Half-size black line prints of wiring diagrams applicable to each control panel shall be placed in clear plastic envelopes and stored in a suitable print pocket or container inside each control panel.

3) Submit CADD drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.

D. Maintenance Materials Submittals: Submit the following:
   1. Spare Parts and Test Equipment
      a. General
         1) Furnish the spare parts and test equipment as indicated below, identical to and interchangeable with similar equipment provided under this Section.
         2) Provide source quality control for spare parts as part of factory testing prior to shipment of control equipment.
         3) For process sensors and other analog instruments, Supplier shall submit a separate quotation for recommended list of spare parts and test equipment. Separately list and price each item recommended. Spare parts quotation shall include a statement that prices quoted are valid for a period of one year from date of equipment installation and that Supplier understands that OWNER reserves the right to purchase none, any, or all parts quoted. Upon request, Supplier shall submit documentation that stock of spare parts and test equipment is obtainable within 48 hours of receipt of OWNER's order.
      b. Furnish the following spare parts:
         1) One switch of each type provided.
         2) Two (2) SFP modules of each type provided.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prior to packaging, each manufacturer or Supplier shall securely attach tag number and instructions for proper field handling and installation to each instrument.

PART 2 – PRODUCTS

2.1 RACK-MOUNTABLE MANAGED FIBER-OPTIC ETHERNET SWITCH (Mounted in FOCE-ABF)

A. General:
   1. Provide rack-mountable, Layer-2 managed Ethernet switch for connection to the existing control network as shown in the system architecture drawings and specified herein. The switch shall be used to create an additional node on the existing fault tolerant fiber optic ring with automatic failover.
   2. Provide network enclosure for the Layer-2 managed Ethernet switch with all appurtenances as listed herein.

B. Physical Features:
   1. Modular 19" Rack Mount Enclosure mounting.
   2. Modular construction that additional copper and fiber ports can be added and removed to SFP ports.
   3. Minimum SFP compatible fiber uplink ports: 8x SFP+ 1GB/10GB
   4. Minimum supplied SFP modules: Four SFP Fiber duplex LC ports matching existing plant Multimode fiber optic cable. Dust caps shall be provided for SFP modules not in use.
   5. Minimum copper ports: 36 ports POE++ 10/100/1000Mps
   6. Operating temperature 0 to 113°F
   7. Power: 120VAC Built-In Redundant Power Supplies.
   8. Enclosure: Metal Case

C. Network Features.
   1. Fault tolerance for use in ring topology. Switch must support STP, MTP and RSTP.
   2. Auto negotiation and manual configurable speed and duplex on all copper ports.
   3. GUI, CLI & SSH management.
   4. SNMP management for SCADA connection.
   5. IGMP Snooping IGMPv3, IGMP Filtering.
   6. VLAN Support: Static, Dynamic, Voice, MAC. GVRP/GMRP, Private VLANs
   7. Trunking: Auto-Trunk and Auto-Lag with Netgear M4250 Switches.
   8. Configuration password protection.
   9. Configuration Backup capabilities to upload to a replacement switch.
   10. Ipv4/IPv6 Static and Dynamic Routing.
   11. MAC filtering.

D. Manufacturers.
   1. Netgear.
   2. Cisco.
   3. Stratix.
   4. Or Equal.

2.2 CONTROL PANEL MOUNTED INDUSTRIAL MANAGED ETHERNET SWITCH – PLC-ABF, PLC-BCP-1 to PLC-BCP-5

A. General:
   1. This specification applies to Ethernet switches required within PLC enclosures or RIO panels as required for local or remote I/O.
   2. Provide an industrial managed Ethernet switch for internal connection where a direct connection to FOCE-ABF as shown in the contract Drawings and specified is feasible.

3. Coordinate with the plant for all IP and VLAN configurations required including updating all Purdue Networking documentation. This includes updating plant networking spreadsheets and system drawings.

B. Physical Features:
   1. Minimum copper ports: 8 x 10/100/1000 TX RJ45 ports. The final quantity of copper ports shall be based on the equipment connection to each switch and must include a minimum of 3 ports designated for spare.
   2. Power: 24VDC redundant power supply inputs.
   3. Enclosure: Metal case, DIN-rail mountable.

C. Network Features:
   1. Full duplex on all ports.
   2. Auto negotiation and manual configurable speed and duplex on all copper ports.
   3. GUI, CLI & SSH management.
   4. SNMP management for SCADA connection.
   5. IGMP Snooping IGMPv3, IGMP Filtering.
   6. VLAN Support: Static, Dynamic, Voice, MAC. GVRP/GMRP, Private VLANs
   7. Trunking: Auto-Trunk and Auto-Lag with Netgear M4250 Switches.
   8. Configuration password protection.
   9. Configuration Backup capabilities to upload to a replacement switch.
   10. Ipv4/IPv6 Static and Dynamic Routing.
   11. MAC filtering.

D. Manufacturers:
   1. Weidmuller.
   2. Phoenix Contact.
   3. Or equal.

2.3 FIBER OPTIC TERMINATION PATCH PANEL – FOCE-ABF.

A. General:
   1. Fiber optic patch panel (FOPP) shall be provided as indicated on the contract Drawings for mounting within the FOCE-ABF.
   2. Fiber optic patch panel will provide the terminations from the plant fiber optic 12 pair OM4 network cables. All fiber cables within the exposed buffer tube shall be terminated at patch panels with fan out kits with pre-connected pigtails. The patch panel shall have a fiber capacity equal to the total number of fibers (connected and spare) for all cables to be connected.
   3. Fiber optic patch panels will connect the plant fiber optic cable via jumpers to the Layer 2 Fiber Optic switch.
   4. All fiber optic connections shall be of the Duplex LC type.
   5. The termination patch panel shall be equipped with a suitable means for routing and securing of cables, and shall provide a suitable means of protection for the mounted fiber connectors to prevent damage to fibers and

connectors during all regular operations and maintenance functions. All cables shall be provided with strain relief. Bend diameters on cable fibers and jumpers must be great than 25% above the listed diameter minimums by the manufacturer.

B. Physical Features:
   1. 19" Rack Mount. Minimum of 3U of height.
   2. Removable molded plastic cover over terminations.
   3. Ability to accept at a minimum 12 adapter panels.
   4. Supplied with a minimum of two (2) 12-pair LC duplex panels.
   5. Supplied with Blank Inserts for unused internal panel slots.
   6. Supplied with a Fiber Optic Splice Tray for each fiber panel slot.
   7. Supplied with Duplex NEMA-5-20R receptacle mounted with a feed from the 20A circuit breaker within the power panel.

C. Manufacturers:
   1. Black Box.
   2. Corning.
   3. Or equal.

2.4 19" FIXED WALL MOUNT FIBER OPTIC COMMUNICATIONS ENCLOSURE – FOCE-ABF.

A. General:
   1. 19" network rack shall be wall-mounted in a fixed enclosure that allows for front and rear access.
   2. The contractor shall furnish and install any and all appurtenances required for a fully functional network rack. The network rack shall have a minimum of 22U capacity.
   3. The contractor is responsible for sizing of the rack to ensure that it has sufficient capacity to accommodate the equipment being furnished.

B. Features:
   1. Enclosed and removable sides and front door.
   2. Front door equipped with lock and key. No access permitted to internal components when door is shut and locked.
   3. Cable management rings per wired device plus any as needed for clean routing of cables.
   4. 19" Rack Mountable Cat6 patch panel with a minimum of 48 copper ports.
   5. 19" Rackmount Fiber Optic Patch Panel as specified herein.
   6. Rackmounted managed Layer 2 Ethernet Switch as specified herein.
   7. Rackmount Uninterruptible Power supply as specified in section 16261.
   8. Rackmount Power Distribution Unit mounted to provide power for all non-UPS devices such as fans.
   9. Refer to the drawings for rack layout requirements.
   10. Hardware necessary for proper floor mounting.

C. Manufacturers:
   1. Tripplite.
   2. Eaton.
   3. Hubble.
   4. Rittal.
   5. Or equal.

2.5 COPPER CABLES AND CONNECTORS.

A. Ethernet:
   1. For all copper-based cable connections provide twisted pair cable designed for high speed (10/100/1000Mbps) Ethernet 10/100/1000BASE-T/TX communications network.
   2. Copper-based cable must meet or exceed ISO/IEC 11801 standard for Cat 6a cabling.
   3. Maximum distance of any copper based Cat 6a cable must not exceed 100 meters from network device to network device.
   4. Cables within an enclosure shall be factory terminated with RJ-45 connectors.
   5. Cables between enclosures shall either be factory terminated or field terminated with RJ-45 connectors.

B. Manufacturers:
   1. Belden.
   2. Or equal

2.6 FIBER OPTIC CABLES AND CONNECTORS – PLANT FIBER-OPTIC RING.

A. Scope:
   1. New OM4 multimode fiber optic cable shall be provided to tie the new FOCE-ABF fiber optic switch into the existing plant network in between the existing FOCE-OPS and FOCE-RAS.
   2. The new fiber-optic link will match the existing 12-pair (24-strand) system terminations and utilized and reserved networks. New patching layout shall match the existing patching layouts.
   3. Refer to the fiber optic network drawings and system architecture drawings for a depiction of the modified fiber optic network design.
   4. All fiber optic cables will be required to be terminated and tested at the new fiber optic patch panel as shown on the drawings and specified herein, along with the existing fiber optic patch panels at FOCE-OPS and FOCE-RAS.

B. Ethernet Fiber-Optic Cables – 12-Pair OM4:
   1. 12 pairs of OM4 categorized cable. 24 individual fibers.
   2. 50/125 micron glass fiber operating at 850/1300nm wavelengths.
   3. Distance from network device to network device to not exceed 300 meters.
   4. Cable shall be flame-retardant, UV stabilized, fully water blocked with dielectric central member for use in indoor/outdoor applications. The buffer tubes shall be gel-free. Each buffer tube shall contain a water-swellable yarn for water-blocking protection. Cable shall be suitable for installation duct,

aerial and riser environments. Cable shall meet UL OFNR specifications and not require transition splicing upon building entry in order to meet fire codes.

5. Flame Rating/ Reaction to Fire must meet or exceed UL1666 Riser, UL 1685 FT4.
6. Operating Temperature: -40°C to +70°C.
7. All Optical fibers shall be placed within a buffer tube, each containing 12 fibers (6 pairs).
8. Buffer tubes shall be kink resistant up to the manufacturer's minimum bend radius.
9. The cable shall have a minimum bend radius of 10 x cable OD
10. The cable shall have a crush resistance of 200 N/cm minimum.
11. The cable shall comply with TIA-492-AAAD OM4 classification.
12. The cable outer jacket shall be orange and marked with the manufacturer's name, date of manufacturer, fiber type, flame rating, UL symbol and distance markings. Labels shall be in contrast to the jacket color.
13. The cable shall be supplied with a ripcord under the cable jacket to allow removal of the individual fibers without damage.
14. Individual fibers shall be color coded per EIA/TIA-598.
15. The cable outer jacket shall

C. Pulling:
   1. Cables shall be pulled as specified in Division 16.
   2. Pulling lubricant shall be specifically intended for fiber optic cable installation.

D. WARNING TAPE
   1. Metal detectable warning tape shall be installed 4"-6" below grade above any buried fiber optic cable. Tape shall be constructed of 5 mil orange polyester material, 2-in minimum width. Tape shall be capable of being detected or located by either conductive or inductive location techniques.
   2. Black lettering shall read "CAUTION: BURIED FIBER OPTIC LINE BELOW." .
   3. Warning tape shall be Brady Catalog #91606 or equal.

C. Terminations:
   1. All fiber cables within the fiber optic cable shall be terminated at patch panels with fan out kits with pre-connected pigtails. No terminated fiber optic cables shall be non-terminated and/or not landed at the patch panel. All spares must be terminated and landed on the patch panel.
   2. All terminations of the fiber optic cables shall be Duplex LC type.

D. Testing:
   1. Submit certified factory test reports as a submittal as specified herein. Factory testing shall conform to applicable ICEA standards.
   2. Cable to be pre-tested utilizing an Optical Time Domain Reflectometer (OTDR) to verify no damage has occurred during shipping or storage before installation. Submit test results showing no damage. For Multimode fiber the maximum allowable attenuation is 3.5dB/km at 850nm and 1.5 dB/km at

1300nm. The Contractor shall replace any cable in which any fiber strand within that cable does not meet this requirement. Cable shall not be installed until the Engineer has reviewed and approved the field test report.

3. Cable shall be re-tested following terminations with a field test report submitted for review by the Engineer.

E. Spare Parts:
   1. QTY twelve (12) LC Duplex Pair Connectors for a total of twenty-four (24) fibers.

2.7 RACK MOUNTED UNINTERRUPTIBLE POWER SUPPLY – FOCE-ABF.

A. General:
   1. UPS system shall utilize a field proven design. The UPS manufacturer shall demonstrate at least ten years of continuous field operating experience with equipment of similar size and design.
   2. Equipment shall be UL or ETL labeled.
   3. The UPS manufacturer shall have ISO 9001 certification.
   4. The UPS shall have a replaceable battery with commonly sourced batteries.
   5. The UPS shall be provided with an external rack mounted service bypass switch mounted near the switch and not exceeding a vertical size of 1U.
   6. The UPS shall have the ability for the batteries to be swapped without interrupting the load power.
   7. Current Limiting circuitry shall be built-in to the UPS.
   8. The UPS shall have SNMP protocol as standard or as part of a supplied additional card. SNMP protocol to be utilized to communicate to the plant's SCADA for monitoring.
   9. The existing Plant SCADA shall be modified to monitor the UPS to match the monitoring of existing UPS units within the plant.
   10. The UPS shall be a continuous-duty, on-line, solid state, line interactive, single-phase uninterruptible power system.
   11. The UPS shall be standard as rack mountable without modification.
   12. Battery runtime: Provide batteries to support 125% of calculated load for a minimum of 30 minutes.
   13. Output power: Provide a minimum kVA rating of 125% of the anticipated kVA rating of the anticipated load.

B. Performance Requirements:
   1. Input Voltage Range: 90-140 VAC. Nominal 120VAC Input.
   2. Input Frequency: 57Hz to 63Hz.
   3. Output Frequency on battery: 60Hz ± 1%.
   4. Output Voltage on battery: 120VAC ± 10%.
   5. Outlets: Battery & Surge Protected 4 minimum. Outlets Surge Only 2 minimum.
   6. Typical Transfer Time: 8ms

7. Surge suppression (Joules): 1150J minimum.
8. Multifunction LED for status.
9. Audible Alarms for Battery Mode, Low Battery, Overload and Fault.
10. SNMP/HTTP Remote Monitoring.
11. Operating Temperature: 32-104 °F
12. RoHS Compliant.

B. Warranty:
1. Refer to Section 01740.
2. In addition to the basic warranty, the UPS manufacturer shall provide a standard warranty for the UPS for a period of one (1) year from the date of purchase.

B. Manufacturers:
1. Cyberpower.
2. Eaton.
3. Or equal.

PART 3 – EXECUTION

3.1 PCS – GENERAL PROVISIONS FOR EXECUTION

A. Refer to Sections 13400 through 13500 for execution requirements for the PCS.

++ END OF SECTION ++

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SECTION 13480

INPUT/OUTPUT POINT LIST

PART 1 GENERAL

1.01 1.1 DESCRIPTION

A. Scope:
1. This Section describes the input/output (I/O) point list, which follows this Section and requirements for configuring the control system database.

B. Related Sections:
1. Section 13401, Process Control System General Provisions.
2. Section 13402, Process Control System Factory Testing.
3. Section 13403, Process Control System Start-Up and Field Testing
4. Section 13404, Process Control System Training
5. Section 13451, PLC Hardware and Software
6. Section 13480, Input Output Point List
7. Section 13491, Process Control Description
8. Section 13570, Control Criteria

1.02 SUBMITTALS

A. For each I/O attribute listed in the I/O list that cannot be used exactly as listed, submit an explanation of the reason for the deviation and propose a method to modify the I/O list information. Do not proceed with any configuration until a method of resolving deviations is accepted by the Engineer.

B. Include the control system I/O database information in the PLC specific submittals for Section 13451, PLC Hardware and Software.

1.03 I/O POINT LIST DESCRIPTION

A. The I/O point list contains the information necessary to configure the PLC I/O interface hardware and to indicate range conversion or signal functions.

B. “TAG” is an alphanumeric character string. For example, the point AE-FI-123A represents:

1. The two letter character string (AE) identifies the facility as follows “BP” for Bay Park and “CC” for Cedar Creek.

2. The next alpha character is the functional identifier and follows ANSI/ISA-S5.1. In the example, the “F” represents flow.

3. The next alpha character (I) is the function identifier. In the example, the "I" represents an analog input.

4. (I-8), and loop or field device (13)

5. The four-digit number (0123) identifies the loop or field device.

6. The final character (A) is used, as required, as a suffix to differentiate multiple points in the same loop.

C. "DESCRIPTION" is an alphanumeric character string that describes the I/O point. Points described as "SPARE" denote pre-wired I/O.

D. "DRAWING NUMBER" shall indicate which contract drawing the I/O point appears on.

E. "SIGNAL TYPE" is one of the following:
1. AI designates an analog input.
2. DI designates a discrete input.
3. AO designates an analog output.
4. DO designates a momentary, maintained or latched discrete output.
5. DNT designates DeviceNet communication.

F. "RANGE" is a numeric value denoting the minimum and maximum signal value of the controlled variable. Information in this column is provided only for analog points. Information in this column shall be provided by Contractor. For all instrumentation, RANGE information shall be provided after the associated instrument is calibrated.

G. "ENGINEERING UNITS" denotes the unit type as it applies to the RANGE. Information in this column shall be provided by Contractor.

H. "POWER FROM" indicates where power for the instrument/device producing the signal originates from.

I. "SIGNAL FROM DEVICE" indicates the instrument/device which produces the signal.

J. "SIGNAL FROM TB" is the terminal block number where the signal wire is terminated. Information in this column shall be provided by Contractor.

K. "SIGNAL FROM TERMINAL #" is the terminal number where the signal wire is terminated. Information in this column shall be provided by Contractor.

L. "SIGNAL FROM TERMINAL #" is the terminal number where the signal wire is terminated. Information in this column shall be provided by Contractor.

M. "SIGNAL TO DEVICE" indicates the instrument/device which receives the signal.

N. "SIGNAL TO TB" is the terminal block number where the signal wire is terminated. Information in this column shall be provided by Contractor.

O. "SIGNAL TO TERMINAL #" is the terminal number where the signal wire is terminated. Information in this column shall be provided by Contractor.

P. "SIGNAL TO TERMINAL #" is the terminal number where the signal wire is terminated. Information in this column shall be provided by Contractor.

Q. "PLC ADDRESS" indicates the device/channel number of the point. Information in this column shall be provided by Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 I/O CONFIGURATION

A. Implement the control system database fields in a consistent manner by using the following procedures:

1. Use abbreviations and acronyms already established in the Contract Documents. In particular, use the information in the I/O Point List.

2. Use only abbreviation or acronym for a word or group of words, respectively.

3. Use the same subject and word order within data fields.

4. Use the same term (either phrase, word or acronym) to denote the same meaning. Do not use multiple terms for a single meaning.

5. Use the point names, descriptions, logic state descriptions, ranges and units of measurement exactly the same wherever the point is referenced.

6. Show point names and descriptions for all point references on documentation.

7. Spell correctly.

8. Maintain lists of acronyms and abbreviations used.

3.02 I/O HARDWARE CONFIGURATION

A. Partition the I/O among cards within an I/O enclosure to provide control loop integrity.

1. Put all inputs of the same I/O type associated with a device (e.g. pump, blower, clarifier or other piece of equipment) on the same card.

2. Put all inputs of the same I/O type for devices arranged in process trains (e.g. a pump, its inlet valve and its outlet valve, or a pump and its associated macerator) on the same card or cards if more than one card is required to accommodate the points.

3. Put all outputs of the same I/O type associated with a device or group of devices in a process train on the same card or cards if more than one card is required to accommodate the points.

4. Where the preceding requirements specified in this paragraph would cause more than 20 percent spare points on a card, points for a device or process train may be split between two consecutive cards.

5. Make unused terminals resulting from partitioning the I/O into pre-wired spares. Provide pre-wired spare points with all cabling and termination internal to the DCU as done for other I/O points.

3.03 POINT DATA FIELDS

A. I/O point data fields may be subject to review and modification by the Engineer during the Shop Drawing review phase. Incorporate changes directed by the Engineer completely into the entire system, at no additional cost to Owner, subject to the following limitations:

1. Limit the total number of modifications to 20 percent of the total number of I/O points.

2. Each unique change will count as one modification. For example, modifying the description, range, and engineering unit on an analog input count as three modifications.

3. Analog input alarm limit definition will not be counted as a modification.

3.04 INPUT/OUTPUT TAGGING

A. Each tag number shall be written as follows IY-###A where:
   1. I = ISA Identification.
   2. Y = Function Identifier.
   3. 1 Digit P&ID number, followed by a 2 Digit Loop Number.
   4. A = Suffix (to distinguish between similar variables).

+ + END OF SECTION + +

++ INPUT/OUTPUT POINT LIST BEGINS ON NEXT PAGE ++

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
SOUTH SHORE AERATION CONTROL PANEL															
BP-PI-2001A	Blower Common Discharge Header Pressure A	I-PID-3	AI			PLC-ABF	PIT-2001A				PLC-ABF				
BP-PI-2001B	Blower Common Discharge Header Pressure B	I-PID-3	AI			PLC-ABF	PIT-2001B				PLC-ABF				
BP-PI-2001C	Blower Common Discharge Header Pressure C	I-PID-3	AI			PLC-ABF	PIT-2001C				PLC-ABF				
BP-AI-2101	Aeration Tank 1 Pass AB Dissolved Oxygen	I-PID-3	AI			PLC-ABF	AIT-2101				PLC-ABF				
BP-FI-2101	Aeration Tank 1 Pass AB Air Header Flow	I-PID-3	AI			PLC-ABF	FIT-2101				PLC-ABF				
BP-HA-2101	Aeration Tank 1 Pass AB Valve Local/Remote	I-PID-3	DI			PLC-ABF	Tank 1 Pass AB Control Valve				PLC-ABF				
BP-UA-2101	Aeration Tank 1 Pass AB Valve Fault	I-PID-3	DI			PLC-ABF	Tank 1 Pass AB Control Valve				PLC-ABF				
BP-ZI-2101O	Aeration Tank 1 Pass AB Valve Opened	I-PID-3	DI			PLC-ABF	Tank 1 Pass AB Control Valve				PLC-ABF				
BP-ZI-2101C	Aeration Tank 1 Pass AB Valve Closed	I-PID-3	DI			PLC-ABF	Tank 1 Pass AB Control Valve				PLC-ABF				
BP-ZC-2101	Aeration Tank 1 Pass AB Valve Position Command	I-PID-3	AO			PLC-ABF	Tank 1 Pass AB Control Valve				PLC-ABF				
BP-ZI-2101	Aeration Tank 1 Pass AB Valve Position Feedback	I-PID-3	AI			PLC-ABF	Tank 1 Pass AB Control Valve				PLC-ABF				
BP-AI-2102	Aeration Tank 1 Pass CD Dissolved Oxygen	I-PID-3	AI			PLC-ABF	AIT-2102				PLC-ABF				
BP-FI-2102	Aeration Tank 1 Pass CD Air Header Flow	I-PID-3	AI			PLC-ABF	FIT-2102				PLC-ABF				
BP-HA-2102	Aeration Tank 1 Pass CD Valve Local/Remote	I-PID-3	DI			PLC-ABF	Tank 1 Pass CD Control Valve				PLC-ABF				
BP-UA-2102	Aeration Tank 1 Pass CD Valve Fault	I-PID-3	DI			PLC-ABF	Tank 1 Pass CD Control Valve				PLC-ABF				
BP-ZI-2102O	Aeration Tank 1 Pass CD Valve Opened	I-PID-3	DI			PLC-ABF	Tank 1 Pass CD Control Valve				PLC-ABF				
BP-ZI-2102C	Aeration Tank 1 Pass CD Valve Closed	I-PID-3	DI			PLC-ABF	Tank 1 Pass CD Control Valve				PLC-ABF				
BP-ZC-2102	Aeration Tank 1 Pass CD Valve Position Command	I-PID-3	AO			PLC-ABF	Tank 1 Pass CD Control Valve				PLC-ABF				
BP-ZI-2102	Aeration Tank 1 Pass CD Valve Position Feedback	I-PID-3	AI			PLC-ABF	Tank 1 Pass CD Control Valve				PLC-ABF				
BP-AI-2201	Aeration Tank 2 Pass CD Dissolved Oxygen	I-PID-3	AI			PLC-ABF	AIT-2201				PLC-ABF				
BP-FI-2201	Aeration Tank 2 Pass CD Air Header Flow	I-PID-3	AI			PLC-ABF	FIT-2201				PLC-ABF				
BP-HA-2201	Aeration Tank 2 Pass CD Valve Local/Remote	I-PID-3	DI			PLC-ABF	Tank 2 Pass CD Control Valve				PLC-ABF				
BP-UA-2201	Aeration Tank 2 Pass CD Valve Fault	I-PID-3	DI			PLC-ABF	Tank 2 Pass CD Control Valve				PLC-ABF				
BP-ZI-2201O	Aeration Tank 2 Pass CD Valve Opened	I-PID-3	DI			PLC-ABF	Tank 2 Pass CD Control Valve				PLC-ABF				
BP-ZI-2201C	Aeration Tank 2 Pass CD Valve Closed	I-PID-3	DI			PLC-ABF	Tank 2 Pass CD Control Valve				PLC-ABF				
BP-ZC-2201	Aeration Tank 2 Pass CD Valve Position Command	I-PID-3	AO			PLC-ABF	Tank 2 Pass CD Control Valve				PLC-ABF				
BP-ZI-2201	Aeration Tank 2 Pass CD Valve Position Feedback	I-PID-3	AI			PLC-ABF	Tank 2 Pass CD Control Valve				PLC-ABF				
BP-AI-2202	Aeration Tank 2 Pass AB Dissolved Oxygen	I-PID-3	AI			PLC-ABF	AIT-2202				PLC-ABF				
BP-FI-2202	Aeration Tank 2 Pass AB Air Header Flow	I-PID-3	AI			PLC-ABF	FIT-2202				PLC-ABF				
BP-HA-2202	Aeration Tank 2 Pass AB Valve Local/Remote	I-PID-3	DI			PLC-ABF	Tank 2 Pass AB Control Valve				PLC-ABF				
BP-UA-2202	Aeration Tank 2 Pass AB Valve Fault	I-PID-3	DI			PLC-ABF	Tank 2 Pass AB Control Valve				PLC-ABF				
BP-ZI-2202O	Aeration Tank 2 Pass AB Valve Opened	I-PID-3	DI			PLC-ABF	Tank 2 Pass AB Control Valve				PLC-ABF				
BP-ZI-2202C	Aeration Tank 2 Pass AB Valve Closed	I-PID-3	DI			PLC-ABF	Tank 2 Pass AB Control Valve				PLC-ABF				
BP-ZC-2202	Aeration Tank 2 Pass AB Valve Position Command	I-PID-3	AO			PLC-ABF	Tank 2 Pass AB Control Valve				PLC-ABF				
BP-ZI-2202	Aeration Tank 2 Pass AB Valve Position Feedback	I-PID-3	AI			PLC-ABF	Tank 2 Pass AB Control Valve				PLC-ABF				

AERATION CONTROL PANEL (ACP) INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
BP-AI-2301	Aeration Tank 3 Pass AB Dissolved Oxygen	I-PID-3	AI			PLC-ABF	AIT-2301				PLC-ABF				
BP-FI-2301	Aeration Tank 3 Pass AB Air Header Flow	I-PID-3	AI			PLC-ABF	FIT-2301				PLC-ABF				
BP-HA-2301	Aeration Tank 3 Pass AB Valve Local/Remote	I-PID-3	DI			PLC-ABF	Tank 3 Pass AB Control Valve				PLC-ABF				
BP-UA-2301	Aeration Tank 3 Pass AB Valve Fault	I-PID-3	DI			PLC-ABF	Tank 3 Pass AB Control Valve				PLC-ABF				
BP-ZI-2301O	Aeration Tank 3 Pass AB Valve Opened	I-PID-3	DI			PLC-ABF	Tank 3 Pass AB Control Valve				PLC-ABF				
BP-ZI-2301C	Aeration Tank 3 Pass AB Valve Closed	I-PID-3	DI			PLC-ABF	Tank 3 Pass AB Control Valve				PLC-ABF				
BP-ZC-2301	Aeration Tank 3 Pass AB Valve Position Command	I-PID-3	AO			PLC-ABF	Tank 3 Pass AB Control Valve				PLC-ABF				
BP-ZI-2301	Aeration Tank 3 Pass AB Valve Position Feedback	I-PID-3	AI			PLC-ABF	Tank 3 Pass AB Control Valve				PLC-ABF				
BP-AI-2302	Aeration Tank 3 Pass CD Dissolved Oxygen	I-PID-3	AI			PLC-ABF	AIT-2302				PLC-ABF				
BP-FI-2302	Aeration Tank 3 Pass CD Air Header Flow	I-PID-3	AI			PLC-ABF	FIT-2302				PLC-ABF				
BP-HA-2302	Aeration Tank 3 Pass CD Valve Local/Remote	I-PID-3	DI			PLC-ABF	Tank 3 Pass CD Control Valve				PLC-ABF				
BP-UA-2302	Aeration Tank 3 Pass CD Valve Fault	I-PID-3	DI			PLC-ABF	Tank 3 Pass CD Control Valve				PLC-ABF				
BP-ZI-2302O	Aeration Tank 3 Pass CD Valve Opened	I-PID-3	DI			PLC-ABF	Tank 3 Pass CD Control Valve				PLC-ABF				
BP-ZI-2302C	Aeration Tank 3 Pass CD Valve Closed	I-PID-3	DI			PLC-ABF	Tank 3 Pass CD Control Valve				PLC-ABF				
BP-ZC-2302	Aeration Tank 3 Pass CD Valve Position Command	I-PID-3	AO			PLC-ABF	Tank 3 Pass CD Control Valve				PLC-ABF				
BP-ZI-2302	Aeration Tank 3 Pass CD Valve Position Feedback	I-PID-3	AI			PLC-ABF	Tank 3 Pass CD Control Valve				PLC-ABF				
BP-AI-2401	Aeration Tank 4 Pass AB Dissolved Oxygen	I-PID-3	AI			PLC-ABF	AIT-2401				PLC-ABF				
BP-FI-2401	Aeration Tank 4 Pass AB Air Header Flow	I-PID-3	AI			PLC-ABF	FIT-2401				PLC-ABF				
BP-HA-2401	Aeration Tank 4 Pass AB Valve Local/Remote	I-PID-3	DI			PLC-ABF	Tank 4 Pass AB Control Valve				PLC-ABF				
BP-UA-2401	Aeration Tank 4 Pass AB Valve Fault	I-PID-3	DI			PLC-ABF	Tank 4 Pass AB Control Valve				PLC-ABF				
BP-ZI-2401O	Aeration Tank 4 Pass AB Valve Opened	I-PID-3	DI			PLC-ABF	Tank 4 Pass AB Control Valve				PLC-ABF				
BP-ZI-2401C	Aeration Tank 4 Pass AB Valve Closed	I-PID-3	DI			PLC-ABF	Tank 4 Pass AB Control Valve				PLC-ABF				
BP-ZC-2401	Aeration Tank 4 Pass AB Valve Position Command	I-PID-3	AO			PLC-ABF	Tank 4 Pass AB Control Valve				PLC-ABF				
BP-ZI-2401	Aeration Tank 4 Pass AB Valve Position Feedback	I-PID-3	AI			PLC-ABF	Tank 4 Pass AB Control Valve				PLC-ABF				
BP-AI-2402	Aeration Tank 4 Pass CD Dissolved Oxygen	I-PID-3	AI			PLC-ABF	AIT-2402				PLC-ABF				
BP-FI-2402	Aeration Tank 4 Pass CD Air Header Flow	I-PID-3	AI			PLC-ABF	FIT-2402				PLC-ABF				
BP-HA-2402	Aeration Tank 4 Pass CD Valve Local/Remote	I-PID-3	DI			PLC-ABF	Tank 4 Pass CD Control Valve				PLC-ABF				
BP-UA-2402	Aeration Tank 4 Pass CD Valve Fault	I-PID-3	DI			PLC-ABF	Tank 4 Pass CD Control Valve				PLC-ABF				
BP-ZI-2402O	Aeration Tank 4 Pass CD Valve Opened	I-PID-3	DI			PLC-ABF	Tank 4 Pass CD Control Valve				PLC-ABF				
BP-ZI-2402C	Aeration Tank 4 Pass CD Valve Closed	I-PID-3	DI			PLC-ABF	Tank 4 Pass CD Control Valve				PLC-ABF				
BP-ZC-2402	Aeration Tank 4 Pass CD Valve Position Command	I-PID-3	AO			PLC-ABF	Tank 4 Pass CD Control Valve				PLC-ABF				
BP-ZI-2402	Aeration Tank 4 Pass CD Valve Position Feedback	I-PID-3	AI			PLC-ABF	Tank 4 Pass CD Control Valve				PLC-ABF				
BP-AI-2501	Aeration Tank 5 Pass AB Dissolved Oxygen	I-PID-3	AI			PLC-ABF	AIT-2501				PLC-ABF				
BP-FI-2501	Aeration Tank 5 Pass AB Air Header Flow	I-PID-3	AI			PLC-ABF	FIT-2501				PLC-ABF				
BP-HA-2501	Aeration Tank 5 Pass AB Valve Local/Remote	I-PID-3	DI			PLC-ABF	Tank 5 Pass AB Control Valve				PLC-ABF				

AERATION CONTROL PANEL (ACP) INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	#	DEVICE	TB	TERMINAL #	#	
BP-UA-2501	Aeration Tank 5 Pass AB Valve Fault	I-PID-3	DI			PLC-ABF	Tank 5 Pass AB Control Valve				PLC-ABF				
BP-ZI-2501O	Aeration Tank 5 Pass AB Valve Opened	I-PID-3	DI			PLC-ABF	Tank 5 Pass AB Control Valve				PLC-ABF				
BP-ZI-2501C	Aeration Tank 5 Pass AB Valve Closed	I-PID-3	DI			PLC-ABF	Tank 5 Pass AB Control Valve				PLC-ABF				
BP-ZC-2501	Aeration Tank 5 Pass AB Valve Position Command	I-PID-3	AO			PLC-ABF	Tank 5 Pass AB Control Valve				PLC-ABF				
BP-ZI-2501	Aeration Tank 5 Pass AB Valve Position Feedback	I-PID-3	AI			PLC-ABF	Tank 5 Pass AB Control Valve				PLC-ABF				
BP-AI-2502	Aeration Tank 5 Pass CD Dissolved Oxygen	I-PID-3	AI			PLC-ABF	AIT-2502				PLC-ABF				
BP-FI-2502	Aeration Tank 5 Pass CD Air Header Flow	I-PID-3	AI			PLC-ABF	FIT-2502				PLC-ABF				
BP-HA-2502	Aeration Tank 5 Pass CD Valve Local/Remote	I-PID-3	DI			PLC-ABF	Tank 5 Pass CD Control Valve				PLC-ABF				
BP-UA-2502	Aeration Tank 5 Pass CD Valve Fault	I-PID-3	DI			PLC-ABF	Tank 5 Pass CD Control Valve				PLC-ABF				
BP-ZI-2502O	Aeration Tank 5 Pass CD Valve Opened	I-PID-3	DI			PLC-ABF	Tank 5 Pass CD Control Valve				PLC-ABF				
BP-ZI-2502C	Aeration Tank 5 Pass CD Valve Closed	I-PID-3	DI			PLC-ABF	Tank 5 Pass CD Control Valve				PLC-ABF				
BP-ZC-2502	Aeration Tank 5 Pass CD Valve Position Command	I-PID-3	AO			PLC-ABF	Tank 5 Pass CD Control Valve				PLC-ABF				
BP-ZI-2502	Aeration Tank 5 Pass CD Valve Position Feedback	I-PID-3	AI			PLC-ABF	Tank 5 Pass CD Control Valve				PLC-ABF				
BP-UA-1119A	Aeration Control Panel PLC System Malfunction	I-PID-3	DI			PLC-ABF	PLC-ABF				PLC-ABF				
BP-UA-1119B	Aeration Control Panel Low PLC Battery	I-PID-3	DI			PLC-ABF	PLC-ABF				PLC-ABF				
BP-AI-2011A	Aeration Tank 1 Pass 1D NH3	I-PID-4	AI			PLC-ABF	AIT-2011				PLC-ABF				
BP-AI-2011B	Aeration Tank 1 Pass 1D NO3	I-PID-4	AI			PLC-ABF	AIT-2011				PLC-ABF				
BP-AI-2012A	Aeration Tank 2 Pass 2D NH3	I-PID-4	AI			PLC-ABF	AIT-2012				PLC-ABF				
BP-AI-2012B	Aeration Tank 2 Pass 2D NO3	I-PID-4	AI			PLC-ABF	AIT-2012				PLC-ABF				
BP-AI-2013A	Aeration Tank 3 Pass 3D NH3	I-PID-5	AI			PLC-ABF	AIT-2013				PLC-ABF				
BP-AI-2013B	Aeration Tank 3 Pass 3D NO3	I-PID-5	AI			PLC-ABF	AIT-2013				PLC-ABF				
BP-AI-2014A	Aeration Tank 4 Pass 4D NH3	I-PID-5	AI			PLC-ABF	AIT-2014				PLC-ABF				
BP-AI-2014B	Aeration Tank 4 Pass 4D NO3	I-PID-5	AI			PLC-ABF	AIT-2014				PLC-ABF				
BP-AI-2015A	Aeration Tank 5 Pass 5D NH3	I-PID-6	AI			PLC-ABF	AIT-2015				PLC-ABF				
BP-AI-2015B	Aeration Tank 5 Pass 5D NO3	I-PID-6	AI			PLC-ABF	AIT-2015				PLC-ABF				
BP-YA-119C	Aeration Tank Control Panel Alarm Horn	I-PID-3	DO			PLC-ABF	PLC-ABF				PLC-ABF				
BP-YA-119D	Aeration Tank Control Panel Alarm Strobe	I-PID-3	DO			PLC-ABF	PLC-ABF				PLC-ABF				
BP-UA-2000	Aeration Header Pressure Relief Valve Fault	I-PID-3	DI			PLC-ABF	Aeration Header Pressure Relief Valve				PLC-ABF				
BP-ZI-2000O	Aeration Header Pressure Relief Valve Opened	I-PID-3	DI			PLC-ABF	Aeration Header Pressure Relief Valve				PLC-ABF				
BP-ZI-2000C	Aeration Header Pressure Relief Valve Closed	I-PID-3	DI			PLC-ABF	Aeration Header Pressure Relief Valve				PLC-ABF				
BP-ZC-2000	Aeration Header Pressure Relief Valve Position Command	I-PID-3	AO			PLC-ABF	Aeration Header Pressure Relief Valve				PLC-ABF				
BP-ZI-2000	Aeration Header Pressure Relief Valve Position Feedback	I-PID-3	AI			PLC-ABF	Aeration Header Pressure Relief Valve				PLC-ABF				

BLOWER 1 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	#	DEVICE	TB	TERMINAL #	#	
SOUTH SHORE BLOWER LOCAL CONTROL PANEL															
BP-PDI-4501A	Blower 1 Inlet Filter 1st Stage Differential Pressure High	I-PID-1	DI			PLC.BCP-1	PDSH-4501A				PLC.BCP-1				
BP-PDI-4501B	Blower 1 Inlet Filter 2nd Stage Differential Pressure High	I-PID-1	DI			PLC.BCP-1	PDSH-4501B				PLC.BCP-1				
BP-TI-4501	Blower 1 Inlet Temperature	I-PID-1	AI			PLC.BCP-1	TIT-4501				PLC.BCP-1				
BP-PI-4501	Blower 1 Inlet Pressure	I-PID-1	AI			PLC.BCP-1	PIT-4501				PLC.BCP-1				
BP-PI-4502	Blower 1 Discharge Pressure	I-PID-1	AI			PLC.BCP-1	PIT-4502				PLC.BCP-1				
BP-TI-4502	Blower 1 Discharge Temperature	I-PID-1	AI			PLC.BCP-1	TIT-4502				PLC.BCP-1				
BP-PDI-4502	Blower 1 Inlet/Outlet Differential Pressure	I-PID-1	AI			PLC.BCP-1	PDIT-4502				PLC.BCP-1				
BP-ZC-4501	Blower 1 Discharge Valve Position Command	I-PID-1	AO			PLC.BCP-1	PDV-4501				PLC.BCP-1				
BP-ZI-4501O	Blower 1 Discharge Valve Opened	I-PID-1	DI			PLC.BCP-1	ZSO-4501				PLC.BCP-1				
BP-ZI-4501C	Blower 1 Discharge Valve Closed	I-PID-1	DI			PLC.BCP-1	ZSC-4501				PLC.BCP-1				
BP-ZI-4501	Blower 1 Discharge Valve Position	I-PID-1	AI			PLC.BCP-1	ZIT-4501				PLC.BCP-1				
BP-UA-4501	Blower 1 Discharge Valve Fault	I-PID-1	DI			PLC.BCP-1	XI-4501				PLC.BCP-1				
BP-HS-4501A	Blower 1 Discharge Valve Local/Remote	I-PID-1	DI			PLC.BCP-1	HS-4501A				PLC.BCP-1				
BP-HS-4501B	Blower 1 Discharge Valve Open/Stop/Close	I-PID-1	DI			PLC.BCP-1	HS-4501B				PLC.BCP-1				
BP-ZC-4502	Blower 1 Blow-Off Valve Position Command	I-PID-1	AO			PLC.BCP-1	BV-4502				PLC.BCP-1				
BP-ZI-4502O	Blower 1 Blow-Off Valve Opened	I-PID-1	DI			PLC.BCP-1	ZSO-4502				PLC.BCP-1				
BP-ZI-4502C	Blower 1 Blow-Off Valve Closed	I-PID-1	DI			PLC.BCP-1	ZSC-4502				PLC.BCP-1				
BP-ZI-4502	Blower 1 Blow-Off Valve Position	I-PID-1	AI			PLC.BCP-1	ZIT-4502				PLC.BCP-1				
BP-UA-4502	Blower 1 Blow-Off Valve Fault	I-PID-1	DI			PLC.BCP-1	XI-4502				PLC.BCP-1				
BP-HS-4502A	Blower 1 Blow-Off Valve Local/Remote	I-PID-1	DI			PLC.BCP-1	HS-4502A				PLC.BCP-1				
BP-HS-4502B	Blower 1 Blow-Off Valve Open/Stop/Close	I-PID-1	DI			PLC.BCP-1	HS-4502B				PLC.BCP-1				
BP-YA-4503	Blower 1 Emergency Stop	I-PID-1	DI			PLC.BCP-1	PLC.BCP-1				PLC.BCP-1				
BP-HR-4503	Blower 1 Motor Start Command	I-PID-1	DO			MCC	MCC				PLC.BCP-1				
BP-YI-4503	Blower 1 Motor Run Status	I-PID-1	DI			MCC	MCC				PLC.BCP-1				
BP-UA-4503	Blower 1 Motor Fault	I-PID-1	DI			MCC	MCC				PLC.BCP-1				
BP-IT-4503	Blower 1 Motor Current	I-PID-1	AI			MCC	MCC				PLC.BCP-1				
BP-VI-4503X	Blower 1 Motor X-Axis Vibration	I-PID-1	AI			PLC.BCP-1	VE-4503X				PLC.BCP-1				
BP-VI-4503Y	Blower 1 Motor Y-Axis Vibration	I-PID-1	AI			PLC.BCP-1	VE-4503Y				PLC.BCP-1				
BP-VI-4503Z	Blower 1 Motor Z-Axis Vibration	I-PID-1	AI			PLC.BCP-1	VE-4503Z				PLC.BCP-1				
BP-TI-4503A	Blower 1 Motor Phase A Winding Temperature	I-PID-1	AI			PLC.BCP-1	TE-4503A				PLC.BCP-1				
BP-TI-4503B	Blower 1 Motor Phase B Winding Temperature	I-PID-1	AI			PLC.BCP-1	TE-4503B				PLC.BCP-1				
BP-TI-4503C	Blower 1 Motor Phase C Winding Temperature	I-PID-1	AI			PLC.BCP-1	TE-4503C				PLC.BCP-1				
BP-TI-4503D	Blower 1 Motor Non-Drive End Temperature	I-PID-1	AI			PLC.BCP-1	TE-4503D				PLC.BCP-1				
BP-TI-4503E	Blower 1 Motor Drive End Temperature	I-PID-1	AI			PLC.BCP-1	TE-4503E				PLC.BCP-1				

BLOWER 1 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	#	DEVICE	TB	TERMINAL #	#	
BP-ZC-4504	Blower 1 Inlet Guide Vanes Position Command	I-PID-1	AO			PLC.BCP-1	ZC-4504				PLC.BCP-1				
BP-ZI-4504	Blower 1 Inlet Guide Vanes Position Feedback	I-PID-1	AI			PLC.BCP-1	ZIT-4504				PLC.BCP-1				
BP-ZI-4504O	Blower 1 Inlet Guide Vanes Opened	I-PID-1	DI			PLC.BCP-1	ZSO-4504				PLC.BCP-1				
BP-ZI-4504C	Blower 1 Inlet Guide Vanes Closed	I-PID-1	DI			PLC.BCP-1	ZSC-4504				PLC.BCP-1				
BP-ZC-4505	Blower 1 Variable Diffuser Position Command	I-PID-1	AO			PLC.BCP-1	ZC-4505				PLC.BCP-1				
BP-ZI-4505	Blower 1 Variable Diffuser Position Feedback	I-PID-1	AI			PLC.BCP-1	ZIT-4505				PLC.BCP-1				
BP-ZI-4505O	Blower 1 Variable Diffuser Opened	I-PID-1	DI			PLC.BCP-1	ZSO-4505				PLC.BCP-1				
BP-ZI-4505C	Blower 1 Variable Diffuser Closed	I-PID-1	DI			PLC.BCP-1	ZSC-4505				PLC.BCP-1				
BP-TI-4506A	Blower 1 Gearbox Temperature A	I-PID-1	AI			PLC.BCP-1	TIT-4506A				PLC.BCP-1				
BP-TI-4506B	Blower 1 Gearbox Temperature B	I-PID-1	AI			PLC.BCP-1	TIT-4506B				PLC.BCP-1				
BP-TI-4506C	Blower 1 Gearbox Temperature C	I-PID-1	AI			PLC.BCP-1	TIT-4506C				PLC.BCP-1				
BP-TI-4506D	Blower 1 Gearbox Temperature D	I-PID-1	AI			PLC.BCP-1	TIT-4506D				PLC.BCP-1				
BP-VI-4506A	Blower 1 Gearbox Vibration A Sensor	I-PID-1	AI			PLC.BCP-1	VE-4506A				PLC.BCP-1				
BP-VI-4506B	Blower 1 Gearbox Vibration B Sensor	I-PID-1	AI			PLC.BCP-1	VE-4506B				PLC.BCP-1				
BP-VI-4506C	Blower 1 Gearbox Vibration C Sensor	I-PID-1	AI			PLC.BCP-1	VE-4506C				PLC.BCP-1				
BP-VI-4506D	Blower 1 Gearbox Vibration D Sensor	I-PID-1	AI			PLC.BCP-1	VE-4506D				PLC.BCP-1				
BP-VI-4506E	Blower 1 Gearbox Vibration E Sensor	I-PID-1	AI			PLC.BCP-1	VE-4506E				PLC.BCP-1				
BP-VI-4506F	Blower 1 Gearbox Vibration F Sensor	I-PID-1	AI			PLC.BCP-1	VE-4506F				PLC.BCP-1				
BP-TI-4507	Blower 1 Discharge Expansion Cone Temperature	I-PID-1	AI			PLC.BCP-1	TIT-4507				PLC.BCP-1				
BP-SI-4508	Blower 1 Zero Speed Switch	I-PID-1	DI			PLC.BCP-1	SS-4508				PLC.BCP-1				
BP-HS-4509	Blower 1 Motor Heater Energize	I-PID-1	DO			PLC.BCP-1	Blower 1 Motor Heater				PLC.BCP-1				
BP-YI-4509	Blower 1 Motor Heater Run Status	I-PID-1	DI			PLC.BCP-1	Blower 1 Motor Heater				PLC.BCP-1				
BP-UA-4509	Blower 1 Motor Heater Fault	I-PID-1	DI			PLC.BCP-1	Blower 1 Motor Heater				PLC.BCP-1				
BP-LAL-4510	Blower 1 Lube Oil Reservoir Low Level Switch	I-PID-2	DI			PLC.BCP-1	LSL-4510				PLC.BCP-1				
BP-LALL-4510	Blower 1 Lube Oil Reservoir Low Low Level Switch	I-PID-2	DI			PLC.BCP-1	LSLL-4510				PLC.BCP-1				
BP-TI-4510	Blower 1 Lube Oil Reservoir Temperature	I-PID-2	AI			PLC.BCP-1	TIT-4510				PLC.BCP-1				
BP-HS-4511	Blower 1 Lube Oil Aux. Pump Start Command	I-PID-2	DO			MCC	HS-4511				PLC.BCP-1				
BP-YI-4511	Blower 1 Lube Oil Aux. Pump Running Status	I-PID-2	DI			MCC	YIL-4511				PLC.BCP-1				
BP-XI-4511	Blower 1 Lube Oil Aux. Pump Overload	I-PID-2	DI			MCC	XI-4511				PLC.BCP-1				
BP-HS-4512	Blower 1 Lube Oil Reservoir Immersion Heater Energize Command	I-PID-2	DO			MCC	XS-4512				PLC.BCP-1				
BP-YI-4512	Blower 1 Lube Oil Reservoir Immersion Heater Run Status	I-PID-2	DI			MCC	YIL-4512				PLC.BCP-1				
BP-UA-4512	Blower 1 Lube Oil Reservoir Immersion Heater Fault	I-PID-2	DI			MCC	XI-4512				PLC.BCP-1				
BP-TAL-4510	Blower 1 Lube Oil Reservoir Temperature Switch Low	I-PID-2	DI			PLC.BCP-1	TSL-4510				PLC.BCP-1				
BP-HS-4513	Blower 1 Lube Oil Heat Exchanger Cooling Water Return Valve Open Command	I-PID-2	DO			PLC.BCP-1	SOV-4513				PLC.BCP-1				
BP-ZI-4513O	Blower 1 Lube Oil Heat Exchanger Cooling Water Return Valve Opened	I-PID-2	DI			PLC.BCP-1	ZSO-4513				PLC.BCP-1				

BLOWER 1 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	#	DEVICE	TB	TERMINAL #	#	
BP-ZI-4513C	Blower 1 Lube Oil Heat Exchanger Cooling Water Return Valve Closed	I-PID-2	DI			PLC.BCP-1	ZSC-4513				PLC.BCP-1				
BP-TC-4514	Blower 1 Lube Oil Temperature Control	I-PID-2	AO			PLC.BCP-1	TCV-4514				PLC.BCP-1				
BP-PDI-4515	Blower 1 Lube Oil Filter Differential Pressure High	I-PID-2	DI			PLC.BCP-1	PDSH-4515				PLC.BCP-1				
BP-PC-4516	Blower 1 Lube Oil Pressure Control	I-PID-2	AO			PLC.BCP-1	PCV-4516				PLC.BCP-1				
BP-PI-4517	Blower 1 Lube Oil Supply Pressure	I-PID-2	AI			PLC.BCP-1	PIT-4517				PLC.BCP-1				
BP-TI-4517	Blower 1 Lube Oil Supply Temperature	I-PID-2	AI			PLC.BCP-1	TIT-4517				PLC.BCP-1				
BP-HS-4518	Blower 1 Lube Oil Reservoir Mist Filter Run Command	I-PID-2	DO			PLC.BCP-1	HS-4518				PLC.BCP-1				
BP-YI-4518	Blower 1 Lube Oil Reservoir Mist Filter Run Status	I-PID-2	DI			PLC.BCP-1	YIL-4518				PLC.BCP-1				
BP-UA-4518	Blower 1 Lube Oil Reservoir Mist Filter Fault	I-PID-2	DI			PLC.BCP-1	XI-4518				PLC.BCP-1				
BP-UA-4518A	Blower 1 Local Control Panel PLC System Malfunction	I-PID-2	DI			PLC.BCP-1	PLC.BCP-1				PLC.BCP-1				
BP-UA-4518B	Blower 1 Local Control Panel Low PLC Battery	I-PID-2	DI			PLC.BCP-1	PLC.BCP-1				PLC.BCP-1				
BP-UA-4519A	Aeration Control Panel PLC System Fault	I-PID-2	DI			PLC.BCP-1	PLC.BCP-1				PLC.BCP-1				
BP-UA-4519B	Aeration Control Panel Low PLC Battery	I-PID-2	DI			PLC.BCP-1	PLC.BCP-1				PLC.BCP-1				
BP-YA-4519C	Blower 1 Control Panel Alarm Horn	I-PID-2	DO			PLC.BCP-1	PLC.BCP-1				PLC.BCP-1				
BP-YA-4519D	Blower 1 Control Panel Alarm Strobe	I-PID-2	DO			PLC.BCP-1	PLC.BCP-1				PLC.BCP-1				
BP-PDI-4520	Blower 1 Low Lube Oil Pressure Low	I-PID-2	DI			PLC.BCP-1	PSL-4520				PLC.BCP-1				

BLOWER 2 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
SOUTH SHORE BLOWER LOCAL CONTROL PANEL															
BP-PDI-4551A	Blower 2 Inlet Filter 1st Stage Differential Pressure High	I-PID-1	DI			PLC.BCP-2	PDSH-4551A				PLC.BCP-2				
BP-PDI-4551B	Blower 2 Inlet Filter 2nd Stage Differential Pressure High	I-PID-1	DI			PLC.BCP-2	PDSH-4551B				PLC.BCP-2				
BP-TI-4551	Blower 2 Inlet Temperature	I-PID-1	AI			PLC.BCP-2	TIT-4551				PLC.BCP-2				
BP-PI-4551	Blower 2 Inlet Pressure	I-PID-1	AI			PLC.BCP-2	PIT-4551				PLC.BCP-2				
BP-PI-4552	Blower 2 Discharge Pressure	I-PID-1	AI			PLC.BCP-2	PIT-4552				PLC.BCP-2				
BP-TI-4552	Blower 2 Discharge Temperature	I-PID-1	AI			PLC.BCP-2	TIT-4552				PLC.BCP-2				
BP-PDI-4552	Blower 2 Inlet/Outlet Differential Pressure	I-PID-1	AI			PLC.BCP-2	PDIT-4552				PLC.BCP-2				
BP-ZC-4551	Blower 2 Discharge Valve Position Command	I-PID-1	AO			PLC.BCP-2	PDV-4551				PLC.BCP-2				
BP-ZI-4551O	Blower 2 Discharge Valve Opened	I-PID-1	DI			PLC.BCP-2	ZSO-4551				PLC.BCP-2				
BP-ZI-4551C	Blower 2 Discharge Valve Closed	I-PID-1	DI			PLC.BCP-2	ZSC-4551				PLC.BCP-2				
BP-ZI-4551	Blower 2 Discharge Valve Position	I-PID-1	AI			PLC.BCP-2	ZIT-4551				PLC.BCP-2				
BP-UA-4551	Blower 2 Discharge Valve Fault	I-PID-1	DI			PLC.BCP-2	XI-4551				PLC.BCP-2				
BP-HS-4551A	Blower 2 Discharge Valve Local/Remote	I-PID-1	DI			PLC.BCP-2	HS-4551A				PLC.BCP-2				
BP-HS-4551B	Blower 2 Discharge Valve Open/Stop/Close	I-PID-1	DI			PLC.BCP-2	HS-4551B				PLC.BCP-2				
BP-ZC-4552	Blower 2 Blow-Off Valve Position Command	I-PID-1	AO			PLC.BCP-2	BV-4552				PLC.BCP-2				
BP-ZI-4552O	Blower 2 Blow-Off Valve Opened	I-PID-1	DI			PLC.BCP-2	ZSO-4552				PLC.BCP-2				
BP-ZI-4552C	Blower 2 Blow-Off Valve Closed	I-PID-1	DI			PLC.BCP-2	ZSC-4552				PLC.BCP-2				
BP-ZI-4552	Blower 2 Blow-Off Valve Position	I-PID-1	AI			PLC.BCP-2	ZIT-4552				PLC.BCP-2				
BP-UA-4552	Blower 2 Blow-Off Valve Fault	I-PID-1	DI			PLC.BCP-2	XI-4552				PLC.BCP-2				
BP-HS-4552A	Blower 2 Blow-Off Valve Local/Remote	I-PID-1	DI			PLC.BCP-2	HS-4552A				PLC.BCP-2				
BP-HS-4552B	Blower 2 Blow-Off Valve Open/Stop/Close	I-PID-1	DI			PLC.BCP-2	HS-4552B				PLC.BCP-2				
BP-YA-4551	Blower 2 Emergency Stop	I-PID-1	DI			PLC.BCP-2	PLC.BCP-2				PLC.BCP-2				
BP-HR-4553	Blower 2 Motor Start Command	I-PID-1	DO			MCC	MCC				PLC.BCP-2				
BP-YI-4553	Blower 2 Motor Run Status	I-PID-1	DI			MCC	MCC				PLC.BCP-2				
BP-UA-4553	Blower 2 Motor Fault	I-PID-1	DI			MCC	MCC				PLC.BCP-2				
BP-IT-4553	Blower 2 Motor Current	I-PID-1	AI			MCC	MCC				PLC.BCP-2				
BP-VI-4553X	Blower 2 Motor X-Axis Vibration	I-PID-1	AI			PLC.BCP-2	VE-4553X				PLC.BCP-2				
BP-VI-4553Y	Blower 2 Motor Y-Axis Vibration	I-PID-1	AI			PLC.BCP-2	VE-4553Y				PLC.BCP-2				
BP-VI-4553Z	Blower 2 Motor Z-Axis Vibration	I-PID-1	AI			PLC.BCP-2	VE-4553Z				PLC.BCP-2				
BP-TI-4553A	Blower 2 Motor Phase A Winding Temperature	I-PID-1	AI			PLC.BCP-2	TE-4553A				PLC.BCP-2				
BP-TI-4553B	Blower 2 Motor Phase B Winding Temperature	I-PID-1	AI			PLC.BCP-2	TE-4553B				PLC.BCP-2				
BP-TI-4553C	Blower 2 Motor Phase C Winding Temperature	I-PID-1	AI			PLC.BCP-2	TE-4553C				PLC.BCP-2				
BP-TI-4553D	Blower 2 Motor Non-Drive End Temperature	I-PID-1	AI			PLC.BCP-2	TE-4553D				PLC.BCP-2				
BP-TI-4553E	Blower 2 Motor Drive End Temperature	I-PID-1	AI			PLC.BCP-2	TE-4553E				PLC.BCP-2				
BP-ZC-4554	Blower 2 Inlet Guide Vanes Position Command	I-PID-1	AO			PLC.BCP-2	ZC-4554				PLC.BCP-2				

BLOWER 2 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
BP-ZI-4554	Blower 2 Inlet Guide Vanes Position Feedback	I-PID-1	AI			PLC.BCP-2	ZIT-4554				PLC.BCP-2				
BP-ZI-4554O	Blower 2 Inlet Guide Vanes Opened	I-PID-1	DI			PLC.BCP-2	ZSO-4554				PLC.BCP-2				
BP-ZI-4554C	Blower 2 Inlet Guide Vanes Closed	I-PID-1	DI			PLC.BCP-2	ZSC-4554				PLC.BCP-2				
BP-ZC-4555	Blower 2 Variable Diffuser Position Command	I-PID-1	AO			PLC.BCP-2	ZC-4555				PLC.BCP-2				
BP-ZI-4555	Blower 2 Variable Diffuser Position Feedback	I-PID-1	AI			PLC.BCP-2	ZIT-4555				PLC.BCP-2				
BP-ZI-4555O	Blower 2 Variable Diffuser Opened	I-PID-1	DI			PLC.BCP-2	ZSO-4555				PLC.BCP-2				
BP-ZI-4555C	Blower 2 Variable Diffuser Closed	I-PID-1	DI			PLC.BCP-2	ZSC-4555				PLC.BCP-2				
BP-TI-4556A	Blower 2 Gearbox Temperature A	I-PID-1	AI			PLC.BCP-2	TE-4556A				PLC.BCP-2				
BP-TI-4556B	Blower 2 Gearbox Temperature B	I-PID-1	AI			PLC.BCP-2	TE-4556B				PLC.BCP-2				
BP-TI-4556C	Blower 2 Gearbox Temperature C	I-PID-1	AI			PLC.BCP-2	TE-4556C				PLC.BCP-2				
BP-TI-4556D	Blower 2 Gearbox Temperature D	I-PID-1	AI			PLC.BCP-2	TE-4556D				PLC.BCP-2				
BP-VI-4556A	Blower 2 Gearbox Vibration A Sensor	I-PID-1	AI			PLC.BCP-2	VE-4556A				PLC.BCP-2				
BP-VI-4556B	Blower 2 Gearbox Vibration B Sensor	I-PID-1	AI			PLC.BCP-2	VE-4556B				PLC.BCP-2				
BP-VI-4556C	Blower 2 Gearbox Vibration C Sensor	I-PID-1	AI			PLC.BCP-2	VE-4556C				PLC.BCP-2				
BP-VI-4556D	Blower 2 Gearbox Vibration D Sensor	I-PID-1	AI			PLC.BCP-2	VE-4556D				PLC.BCP-2				
BP-VI-4556E	Blower 2 Gearbox Vibration E Sensor	I-PID-1	AI			PLC.BCP-2	VE-4556E				PLC.BCP-2				
BP-VI-4556F	Blower 2 Gearbox Vibration F Sensor	I-PID-1	AI			PLC.BCP-2	VE-4556F				PLC.BCP-2				
BP-TI-4557	Blower 2 Discharge Expansion Cone Temperature	I-PID-1	AI			PLC.BCP-2	TIT-4557				PLC.BCP-2				
BP-SI-4558	Blower 2 Zero Speed Switch	I-PID-1	DI			PLC.BCP-2	SS-4558				PLC.BCP-2				
BP-HS-4559	Blower 2 Motor Heater Energize	I-PID-1	DO			PLC.BCP-2	Blower 2 Motor Heater				PLC.BCP-2				
BP-YI-4559	Blower 2 Motor Heater Run Status	I-PID-1	DI			PLC.BCP-2	Blower 2 Motor Heater				PLC.BCP-2				
BP-UA-4559	Blower 2 Motor Heater Fault	I-PID-1	DI			PLC.BCP-2	Blower 2 Motor Heater				PLC.BCP-2				
BP-LAL-4560	Blower 2 Lube Oil Reservoir Low Level Switch	I-PID-2	DI			PLC.BCP-2	LSL-4560				PLC.BCP-2				
BP-LALL-4560	Blower 2 Lube Oil Reservoir Low Low Level Switch	I-PID-2	DI			PLC.BCP-2	LSLL-4560				PLC.BCP-2				
BP-TI-4560	Blower 2 Lube Oil Reservoir Temperature	I-PID-2	AI			PLC.BCP-2	TIT-4560				PLC.BCP-2				
BP-HS-4561	Blower 2 Lube Oil Aux. Pump Start Command	I-PID-2	DO			MCC	HS-4561				PLC.BCP-2				
BP-YI-4561	Blower 2 Lube Oil Aux. Pump Running Status	I-PID-2	DI			MCC	YIL-4561				PLC.BCP-2				
BP-XI-4561	Blower 2 Lube Oil Aux. Pump Overload	I-PID-2	DI			MCC	XI-4561				PLC.BCP-2				
BP-HS-4562	Blower 2 Lube Oil Reservoir Immersion Heater Energize Command	I-PID-2	DO			MCC	XS-4562				PLC.BCP-2				
BP-YI-4562	Blower 2 Lube Oil Reservoir Immersion Heater Run Status	I-PID-2	DI			MCC	YIL-4562				PLC.BCP-2				
BP-UA-4562	Blower 2 Lube Oil Reservoir Immersion Heater Fault	I-PID-2	DI			MCC	XI-4562				PLC.BCP-2				
BP-TAL-4560	Blower 2 Lube Oil Reservoir Temperature Switch Low	I-PID-2	DI			PLC.BCP-2	TSL-4560				PLC.BCP-2				
BP-HS-4563	Blower 2 Lube Oil Heat Exchanger Cooling Water Return Valve Open Command	I-PID-2	DO			PLC.BCP-2	SOV-4563				PLC.BCP-2				
BP-ZI-4563O	Blower 2 Lube Oil Heat Exchanger Cooling Water Return Valve Opened	I-PID-2	DI			PLC.BCP-2	ZSO-4563				PLC.BCP-2				
BP-ZI-4563C	Blower 2 Lube Oil Heat Exchanger Cooling Water Return Valve Closed	I-PID-2	DI			PLC.BCP-2	ZSC-4563				PLC.BCP-2				

BLOWER 2 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
BP-TC-4564	Blower 2 Lube Oil Temperature Control	I-PID-2	AO			PLC.BCP-2	TCV-4564				PLC.BCP-2				
BP-PDI-4565	Blower 2 Lube Oil Filter Differential Pressure High	I-PID-2	DI			PLC.BCP-2	PDSH-4565				PLC.BCP-2				
BP-PC-4566	Blower 2 Lube Oil Pressure Control	I-PID-2	AO			PLC.BCP-2	PCV-4566				PLC.BCP-2				
BP-PI-4567	Blower 2 Lube Oil Supply Pressure	I-PID-2	AI			PLC.BCP-2	PIT-4567				PLC.BCP-2				
BP-TI-4567	Blower 2 Lube Oil Supply Temperature	I-PID-2	AI			PLC.BCP-2	TIT-4567				PLC.BCP-2				
BP-HS-4568	Blower 2 Lube Oil Reservoir Mist Filter Run Command	I-PID-2	DO			PLC.BCP-2	HS-4568				PLC.BCP-2				
BP-YI-4568	Blower 2 Lube Oil Reservoir Mist Filter Run Status	I-PID-2	DI			PLC.BCP-2	YIL-4568				PLC.BCP-2				
BP-UA-4568	Blower 2 Lube Oil Reservoir Mist Filter Fault	I-PID-2	DI			PLC.BCP-2	XI-4568				PLC.BCP-2				
BP-UA-4568A	Blower 2 Local Control Panel PLC System Malfunction	I-PID-2	DI			PLC.BCP-2	PLC.BCP-2				PLC.BCP-2				
BP-UA-4568B	Blower 2 Local Control Panel Low PLC Battery	I-PID-2	DI			PLC.BCP-2	PLC.BCP-2				PLC.BCP-2				
BP-UA-4569A	Aeration Control Panel PLC System Malfunction	I-PID-2	DI			PLC.BCP-2	PLC.BCP-2				PLC.BCP-2				
BP-UA-4569B	Aeration Control Panel Low PLC Battery	I-PID-2	DI			PLC.BCP-2	PLC.BCP-2				PLC.BCP-2				
BP-YA-4569C	Aeration Control Panel Alarm Horn	I-PID-2	DO			PLC.BCP-2	PLC.BCP-2				PLC.BCP-2				
BP-YA-4569D	Aeration Control Panel Alarm Strobe	I-PID-2	DO			PLC.BCP-2	PLC.BCP-2				PLC.BCP-2				
BP-PDI-4570	Blower 2 Low Lube Oil Pressure Low	I-PID-2	DI			PLC.BCP-2	PSL-4570				PLC.BCP-2				

BLOWER 3 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
SOUTH SHORE BLOWER LOCAL CONTROL PANEL															
BP-PDI-4601A	Blower 3 Inlet Filter 1st Stage Differential Pressure High	I-PID-1	DI			PLC.BCP-3	PDSH-4601A				PLC.BCP-3				
BP-PDI-4601B	Blower 3 Inlet Filter 2nd Stage Differential Pressure High	I-PID-1	DI			PLC.BCP-3	PDSH-4601B				PLC.BCP-3				
BP-TI-4601	Blower 3 Inlet Temperature	I-PID-1	AI			PLC.BCP-3	TIT-4601				PLC.BCP-3				
BP-PI-4601	Blower 3 Inlet Pressure	I-PID-1	AI			PLC.BCP-3	PIT-4601				PLC.BCP-3				
BP-PI-4602	Blower 3 Discharge Pressure	I-PID-1	AI			PLC.BCP-3	PIT-4602				PLC.BCP-3				
BP-TI-4602	Blower 3 Discharge Temperature	I-PID-1	AI			PLC.BCP-3	TIT-4602				PLC.BCP-3				
BP-PDI-4602	Blower 3 Inlet/Outlet Differential Pressure	I-PID-1	AI			PLC.BCP-3	PDIT-4602				PLC.BCP-3				
BP-ZC-4601	Blower 3 Discharge Valve Position Command	I-PID-1	AO			PLC.BCP-3	PDV-4601				PLC.BCP-3				
BP-ZI-4601O	Blower 3 Discharge Valve Opened	I-PID-1	DI			PLC.BCP-3	ZSO-4601				PLC.BCP-3				
BP-ZI-4601C	Blower 3 Discharge Valve Closed	I-PID-1	DI			PLC.BCP-3	ZSC-4601				PLC.BCP-3				
BP-ZI-4601	Blower 3 Discharge Valve Position	I-PID-1	AI			PLC.BCP-3	ZIT-4601				PLC.BCP-3				
BP-UA-4601	Blower 3 Discharge Valve Fault	I-PID-1	DI			PLC.BCP-3	XI-4601				PLC.BCP-3				
BP-HS-4601A	Blower 3 Discharge Valve Local/Remote	I-PID-1	DI			PLC.BCP-3	HS-4601A				PLC.BCP-3				
BP-HS-4601B	Blower 3 Discharge Valve Open/Stop/Close	I-PID-1	DI			PLC.BCP-3	HS-4601B				PLC.BCP-3				
BP-ZC-4602	Blower 3 Blow-Off Valve Position Command	I-PID-1	AO			PLC.BCP-3	BV-4602				PLC.BCP-3				
BP-ZI-4602O	Blower 3 Blow-Off Valve Opened	I-PID-1	DI			PLC.BCP-3	ZSO-4602				PLC.BCP-3				
BP-ZI-4602C	Blower 3 Blow-Off Valve Closed	I-PID-1	DI			PLC.BCP-3	ZSC-4602				PLC.BCP-3				
BP-ZI-4602	Blower 3 Blow-Off Valve Position	I-PID-1	AI			PLC.BCP-3	ZIT-4602				PLC.BCP-3				
BP-UA-4602	Blower 3 Blow-Off Valve Fault	I-PID-1	DI			PLC.BCP-3	XI-4602				PLC.BCP-3				
BP-HS-4602A	Blower 3 Blow-Off Valve Local/Remote	I-PID-1	DI			PLC.BCP-3	HS-4602A				PLC.BCP-3				
BP-HS-4602B	Blower 3 Blow-Off Valve Open/Stop/Close	I-PID-1	DI			PLC.BCP-3	HS-4602B				PLC.BCP-3				
BP-YA-4603	Blower 3 Emergency Stop	I-PID-1	DI			PLC.BCP-3	PLC.BCP-3				PLC.BCP-3				
BP-HR-4603	Blower 3 Motor Start Command	I-PID-1	DO			MCC	MCC				PLC.BCP-3				
BP-YI-4603	Blower 3 Motor Run Status	I-PID-1	DI			MCC	MCC				PLC.BCP-3				
BP-UA-4603	Blower 3 Motor Fault	I-PID-1	DI			MCC	MCC				PLC.BCP-3				
BP-IT-4603	Blower 3 Motor Current	I-PID-1	AI			MCC	MCC				PLC.BCP-3				
BP-VI-4603X	Blower 3 Motor X-Axis Vibration	I-PID-1	AI			PLC.BCP-3	VE-4603X				PLC.BCP-3				
BP-VI-4603Y	Blower 3 Motor Y-Axis Vibration	I-PID-1	AI			PLC.BCP-3	VE-4603Y				PLC.BCP-3				
BP-VI-4603Z	Blower 3 Motor Z-Axis Vibration	I-PID-1	AI			PLC.BCP-3	VE-4603Z				PLC.BCP-3				
BP-TI-4603A	Blower 3 Motor Phase A Winding Temperature	I-PID-1	AI			PLC.BCP-3	TE-4603A				PLC.BCP-3				
BP-TI-4603B	Blower 3 Motor Phase B Winding Temperature	I-PID-1	AI			PLC.BCP-3	TE-4603B				PLC.BCP-3				
BP-TI-4603C	Blower 3 Motor Phase C Winding Temperature	I-PID-1	AI			PLC.BCP-3	TE-4603C				PLC.BCP-3				
BP-TI-4603D	Blower 3 Motor Non-Drive End Temperature	I-PID-1	AI			PLC.BCP-3	TE-4603D				PLC.BCP-3				
BP-TI-4603E	Blower 3 Motor Drive End Temperature	I-PID-1	AI			PLC.BCP-3	TE-4603E				PLC.BCP-3				
BP-ZC-4604	Blower 3 Inlet Guide Vanes Position Command	I-PID-1	AO			PLC.BCP-3	ZC-4604				PLC.BCP-3				

BLOWER 3 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	#	DEVICE	TB	TERMINAL #	#	
BP-ZI-4604	Blower 3 Inlet Guide Vanes Position Feedback	I-PID-1	AI			PLC.BCP-3	ZIT-4604				PLC.BCP-3				
BP-ZI-4604O	Blower 3 Inlet Guide Vanes Opened	I-PID-1	DI			PLC.BCP-3	ZSO-4604				PLC.BCP-3				
BP-ZI-4604C	Blower 3 Inlet Guide Vanes Closed	I-PID-1	DI			PLC.BCP-3	ZSC-4604				PLC.BCP-3				
BP-ZC-4605	Blower 3 Variable Diffuser Position Command	I-PID-1	AO			PLC.BCP-3	ZC-4605				PLC.BCP-3				
BP-ZI-4605	Blower 3 Variable Diffuser Position Feedback	I-PID-1	AI			PLC.BCP-3	ZIT-4605				PLC.BCP-3				
BP-ZI-4605O	Blower 3 Variable Diffuser Opened	I-PID-1	DI			PLC.BCP-3	ZSO-4605				PLC.BCP-3				
BP-ZI-4605C	Blower 3 Variable Diffuser Closed	I-PID-1	DI			PLC.BCP-3	ZSC-4605				PLC.BCP-3				
BP-TI-4606A	Blower 3 Gearbox Temperature A	I-PID-1	AI			PLC.BCP-3	TIT-4606A				PLC.BCP-3				
BP-TI-4606B	Blower 3 Gearbox Temperature B	I-PID-1	AI			PLC.BCP-3	TIT-4606B				PLC.BCP-3				
BP-TI-4606C	Blower 3 Gearbox Temperature C	I-PID-1	AI			PLC.BCP-3	TIT-4606C				PLC.BCP-3				
BP-TI-4606D	Blower 3 Gearbox Temperature D	I-PID-1	AI			PLC.BCP-3	TIT-4606D				PLC.BCP-3				
BP-VI-4606A	Blower 3 Gearbox Vibration A Sensor	I-PID-1	AI			PLC.BCP-3	VE-4606A				PLC.BCP-3				
BP-VI-4606B	Blower 3 Gearbox Vibration B Sensor	I-PID-1	AI			PLC.BCP-3	VE-4606B				PLC.BCP-3				
BP-VI-4606C	Blower 3 Gearbox Vibration C Sensor	I-PID-1	AI			PLC.BCP-3	VE-4606C				PLC.BCP-3				
BP-VI-4606D	Blower 3 Gearbox Vibration D Sensor	I-PID-1	AI			PLC.BCP-3	VE-4606D				PLC.BCP-3				
BP-VI-4606E	Blower 3 Gearbox Vibration E Sensor	I-PID-1	AI			PLC.BCP-3	VE-4606E				PLC.BCP-3				
BP-VI-4606F	Blower 3 Gearbox Vibration F Sensor	I-PID-1	AI			PLC.BCP-3	VE-4606F				PLC.BCP-3				
BP-TI-4607	Blower 3 Discharge Expansion Cone Temperature	I-PID-1	AI			PLC.BCP-3	TIT-4607				PLC.BCP-3				
BP-SI-4608	Blower 3 Zero Speed Switch	I-PID-1	DI			PLC.BCP-3	SS-4608				PLC.BCP-3				
BP-HS-4609	Blower 3 Motor Heater Energize	I-PID-1	DO			PLC.BCP-3	Blower 3 Motor Heater				PLC.BCP-3				
BP-YI-4609	Blower 3 Motor Heater Run Status	I-PID-1	DI			PLC.BCP-3	Blower 3 Motor Heater				PLC.BCP-3				
BP-UA-4609	Blower 3 Motor Heater Fault	I-PID-1	DI			PLC.BCP-3	Blower 3 Motor Heater				PLC.BCP-3				
BP-LAL-4610	Blower 3 Lube Oil Reservoir Low Level Switch	I-PID-2	DI			PLC.BCP-3	LSL-4610				PLC.BCP-3				
BP-LALL-4610	Blower 3 Lube Oil Reservoir Low Low Level Switch	I-PID-2	DI			PLC.BCP-3	LSLL-4610				PLC.BCP-3				
BP-TI-4610	Blower 3 Lube Oil Reservoir	I-PID-2	AI			PLC.BCP-3	TIT-4610				PLC.BCP-3				
BP-HS-4611	Blower 3 Lube Oil Aux. Pump Start Command	I-PID-2	DO			MCC	HS-4611				PLC.BCP-3				
BP-YI-4611	Blower 3 Lube Oil Aux. Pump Running Status	I-PID-2	DI			MCC	YIL-4611				PLC.BCP-3				
BP-XI-4611	Blower 3 Lube Oil Aux. Pump Overload	I-PID-2	DI			MCC	XI-4611				PLC.BCP-3				
BP-HS-4612	Blower 3 Lube Oil Reservoir Immersion Heater Energize Command	I-PID-2	DO			MCC	XS-4612				PLC.BCP-3				
BP-YI-4612	Blower 3 Lube Oil Reservoir Immersion Heater Run Status	I-PID-2	DI			MCC	YIL-4612				PLC.BCP-3				
BP-UA-4612	Blower 3 Lube Oil Reservoir Immersion Heater Fault	I-PID-2	DI			MCC	XI-4612				PLC.BCP-3				
BP-TAL-4610	Blower 3 Lube Oil Reservoir Temperature Switch Low	I-PID-2	DI			PLC.BCP-3	TSL-4610				PLC.BCP-3				
BP-HS-4613	Blower 3 Lube Oil Heat Exchanger Cooling Water Return Valve Open Command	I-PID-2	DO			PLC.BCP-3	SOV-4613				PLC.BCP-3				
BP-ZI-4613O	Blower 3 Lube Oil Heat Exchanger Cooling Water Return Valve Opened	I-PID-2	DI			PLC.BCP-3	ZSO-4613				PLC.BCP-3				
BP-ZI-4613C	Blower 3 Lube Oil Heat Exchanger Cooling Water Return Valve Closed	I-PID-2	DI			PLC.BCP-3	ZSC-4613				PLC.BCP-3				

BLOWER 3 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	#	DEVICE	TB	TERMINAL #	#	
BP-TC-4614	Blower 3 Lube Oil Temperature Control	I-PID-2	AO			PLC.BCP-3	TCV-4614				PLC.BCP-3				
BP-PDI-4615	Blower 3 Lube Oil Filter Differential Pressure High	I-PID-2	DI			PLC.BCP-3	PDSH-4615				PLC.BCP-3				
BP-PC-4616	Blower 3 Lube Oil Pressure Control	I-PID-2	AO			PLC.BCP-3	PCV-4616				PLC.BCP-3				
BP-PI-4617	Blower 3 Lube Oil Supply Pressure	I-PID-2	AI			PLC.BCP-3	PIT-4617				PLC.BCP-3				
BP-TI-4617	Blower 3 Lube Oil Supply Temperature	I-PID-2	AI			PLC.BCP-3	TIT-4617				PLC.BCP-3				
BP-HS-4618	Blower 3 Lube Oil Reservoir Mist Filter Run Command	I-PID-2	DO			PLC.BCP-3	HS-4618				PLC.BCP-3				
BP-YI-4618	Blower 3 Lube Oil Reservoir Mist Filter Run Status	I-PID-2	DI			PLC.BCP-3	YIL-4618				PLC.BCP-3				
BP-UA-4618	Blower 3 Lube Oil Reservoir Mist Filter Fault	I-PID-2	DI			PLC.BCP-3	XI-4618				PLC.BCP-3				
BP-UA-4618A	Blower 3 Local Control Panel PLC System Malfunction	I-PID-2	DI			PLC.BCP-3	PLC.BCP-3				PLC.BCP-3				
BP-UA-4618B	Blower 3 Local Control Panel Low PLC Battery	I-PID-2	DI			PLC.BCP-3	PLC.BCP-3				PLC.BCP-3				
BP-UA-4619A	Aeration Control Panel PLC System Malfunction	I-PID-2	DI			PLC.BCP-3	PLC.BCP-3				PLC.BCP-3				
BP-UA-4619B	Aeration Control Panel Low PLC Battery	I-PID-2	DI			PLC.BCP-3	PLC.BCP-3				PLC.BCP-3				
BP-YA-4619C	Aeration Control Panel Alarm Horn	I-PID-2	DO			PLC.BCP-3	PLC.BCP-3				PLC.BCP-3				
BP-YA-4619D	Aeration Control Panel Alarm Strobe	I-PID-2	DO			PLC.BCP-3	PLC.BCP-3				PLC.BCP-3				
BP-PDI-4620	Blower 3 Low Lube Oil Pressure Low	I-PID-2	DI			PLC.BCP-3	PSL-4620				PLC.BCP-3				

BLOWER 4 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
SOUTH SHORE BLOWER LOCAL CONTROL PANEL															
BP-PDI-4651A	Blower 4 Inlet Filter 1st Stage Differential Pressure High	I-PID-1	DI			PLC.BCP-4	PDSH-4651A				PLC.BCP-4				
BP-PDI-4651B	Blower 4 Inlet Filter 2nd Stage Differential Pressure High	I-PID-1	DI			PLC.BCP-4	PDSH-4651B				PLC.BCP-4				
BP-TI-4651	Blower 4 Inlet Temperature	I-PID-1	AI			PLC.BCP-4	TIT-4651				PLC.BCP-4				
BP-PI-4651	Blower 4 Inlet Pressure	I-PID-1	AI			PLC.BCP-4	PIT-4651				PLC.BCP-4				
BP-PI-4652	Blower 4 Discharge Pressure	I-PID-1	AI			PLC.BCP-4	PIT-4652				PLC.BCP-4				
BP-TI-4652	Blower 4 Discharge Temperature	I-PID-1	AI			PLC.BCP-4	TIT-4652				PLC.BCP-4				
BP-PDI-4652	Blower 4 Inlet/Outlet Differential Pressure	I-PID-1	AI			PLC.BCP-4	PDIT-4652				PLC.BCP-4				
BP-ZC-4651	Blower 4 Discharge Valve Position Command	I-PID-1	AO			PLC.BCP-4	PDV-4651				PLC.BCP-4				
BP-ZI-4651O	Blower 4 Discharge Valve Opened	I-PID-1	DI			PLC.BCP-4	ZSO-4651				PLC.BCP-4				
BP-ZI-4651C	Blower 4 Discharge Valve Closed	I-PID-1	DI			PLC.BCP-4	ZSC-4651				PLC.BCP-4				
BP-ZI-4651	Blower 4 Discharge Valve Position	I-PID-1	AI			PLC.BCP-4	ZIT-4651				PLC.BCP-4				
BP-UA-4651	Blower 4 Discharge Valve Fault	I-PID-1	DI			PLC.BCP-4	XI-4651				PLC.BCP-4				
BP-HS-4651A	Blower 4 Discharge Valve Local/Remote	I-PID-1	DI			PLC.BCP-4	HS-4651A				PLC.BCP-4				
BP-HS-4651B	Blower 4 Discharge Valve Open/Stop/Close	I-PID-1	DI			PLC.BCP-4	HS-4651B				PLC.BCP-4				
BP-ZC-4652	Blower 4 Blow-Off Valve Position Command	I-PID-1	AO			PLC.BCP-4	BV-4652				PLC.BCP-4				
BP-ZI-4652O	Blower 4 Blow-Off Valve Opened	I-PID-1	DI			PLC.BCP-4	ZSO-4652				PLC.BCP-4				
BP-ZI-4652C	Blower 4 Blow-Off Valve Closed	I-PID-1	DI			PLC.BCP-4	ZSC-4652				PLC.BCP-4				
BP-ZI-4652	Blower 4 Blow-Off Valve Position	I-PID-1	AI			PLC.BCP-4	ZIT-4652				PLC.BCP-4				
BP-UA-4652	Blower 4 Blow-Off Valve Fault	I-PID-1	DI			PLC.BCP-4	XI-4652				PLC.BCP-4				
BP-HS-4652A	Blower 4 Blow-Off Valve Local/Remote	I-PID-1	DI			PLC.BCP-4	HS-4652A				PLC.BCP-4				
BP-HS-4652B	Blower 4 Blow-Off Valve Open/Stop/Close	I-PID-1	DI			PLC.BCP-4	HS-4652B				PLC.BCP-4				
BP-YA-4653	Blower 4 Emergency Stop	I-PID-1	DO			PLC.BCP-4	PLC.BCP-4				PLC.BCP-4				
BP-HR-4653	Blower 4 Motor Start Command	I-PID-1	DO			MCC	MCC				PLC.BCP-4				
BP-YI-4653	Blower 4 Motor Run Status	I-PID-1	DI			MCC	MCC				PLC.BCP-4				
BP-UA-4653	Blower 4 Motor Fault	I-PID-1	DI			MCC	MCC				PLC.BCP-4				
BP-IT-4653	Blower 4 Motor Current	I-PID-1	AI			MCC	MCC				PLC.BCP-4				
BP-VI-4653X	Blower 4 Motor X-Axis Vibration	I-PID-1	AI			PLC.BCP-4	VE-4653X				PLC.BCP-4				
BP-VI-4653Y	Blower 4 Motor Y-Axis Vibration	I-PID-1	AI			PLC.BCP-4	VE-4653Y				PLC.BCP-4				
BP-VI-4653Z	Blower 4 Motor Z-Axis Vibration	I-PID-1	AI			PLC.BCP-4	VE-4653Z				PLC.BCP-4				
BP-TI-4653A	Blower 4 Motor Phase A Winding Temperature	I-PID-1	AI			PLC.BCP-4	TE-4653A				PLC.BCP-4				
BP-TI-4653B	Blower 4 Motor Phase B Winding Temperature	I-PID-1	AI			PLC.BCP-4	TE-4653B				PLC.BCP-4				
BP-TI-4653C	Blower 4 Motor Phase C Winding Temperature	I-PID-1	AI			PLC.BCP-4	TE-4653C				PLC.BCP-4				
BP-TI-4653D	Blower 4 Motor Non-Drive End Temperature	I-PID-1	AI			PLC.BCP-4	TE-4653D				PLC.BCP-4				
BP-TI-4653E	Blower 4 Motor Drive End Temperature	I-PID-1	AI			PLC.BCP-4	TE-4653E				PLC.BCP-4				
BP-ZC-4654	Blower 4 Inlet Guide Vanes Position Command	I-PID-1	AO			PLC.BCP-4	ZC-4654				PLC.BCP-4				
BP-ZI-4654	Blower 4 Inlet Guide Vanes Position Feedback	I-PID-1	AI			PLC.BCP-4	ZIT-4654				PLC.BCP-4				

BLOWER 4 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
BP-ZI-4654O	Blower 4 Inlet Guide Vanes Opened	I-PID-1	DI			PLC.BCP-4	ZSO-4654				PLC.BCP-4				
BP-ZI-4654C	Blower 4 Inlet Guide Vanes Closed	I-PID-1	DI			PLC.BCP-4	ZSC-4654				PLC.BCP-4				
BP-ZC-4655	Blower 4 Variable Diffuser Position Command	I-PID-1	AO			PLC.BCP-4	ZC-4655				PLC.BCP-4				
BP-ZI-4655	Blower 4 Variable Diffuser Position Feedback	I-PID-1	AI			PLC.BCP-4	ZIT-4655				PLC.BCP-4				
BP-ZI-4655O	Blower 4 Variable Diffuser Opened	I-PID-1	DI			PLC.BCP-4	ZSO-4655				PLC.BCP-4				
BP-ZI-4655C	Blower 4 Variable Diffuser Closed	I-PID-1	DI			PLC.BCP-4	ZSC-4655				PLC.BCP-4				
BP-TI-4656A	Blower 4 Gearbox Temperature A	I-PID-1	AI			PLC.BCP-4	TE-4656A				PLC.BCP-4				
BP-TI-4656B	Blower 4 Gearbox Temperature B	I-PID-1	AI			PLC.BCP-4	TE-4656B				PLC.BCP-4				
BP-TI-4656C	Blower 4 Gearbox Temperature C	I-PID-1	AI			PLC.BCP-4	TE-4656C				PLC.BCP-4				
BP-TI-4656D	Blower 4 Gearbox Temperature D	I-PID-1	AI			PLC.BCP-4	TE-4656D				PLC.BCP-4				
BP-VI-4656A	Blower 4 Gearbox Vibration A Sensor	I-PID-1	AI			PLC.BCP-4	VE-4656A				PLC.BCP-4				
BP-VI-4656B	Blower 4 Gearbox Vibration B Sensor	I-PID-1	AI			PLC.BCP-4	VE-4656B				PLC.BCP-4				
BP-VI-4656C	Blower 4 Gearbox Vibration C Sensor	I-PID-1	AI			PLC.BCP-4	VE-4656C				PLC.BCP-4				
BP-VI-4656D	Blower 4 Gearbox Vibration D Sensor	I-PID-1	AI			PLC.BCP-4	VE-4656D				PLC.BCP-4				
BP-VI-4656E	Blower 4 Gearbox Vibration E Sensor	I-PID-1	AI			PLC.BCP-4	VE-4656E				PLC.BCP-4				
BP-VI-4656F	Blower 4 Gearbox Vibration F Sensor	I-PID-1	AI			PLC.BCP-4	VE-4656F				PLC.BCP-4				
BP-TI-4657	Blower 4 Discharge Expansion Cone Temperature	I-PID-1	AI			PLC.BCP-4	TIT-4657				PLC.BCP-4				
BP-SI-4658	Blower 4 Zero Speed Switch	I-PID-1	DI			PLC.BCP-4	SS-4658				PLC.BCP-4				
BP-HS-4659	Blower 4 Motor Heater Energize	I-PID-1	DO			PLC.BCP-4	Blower 4 Motor Heater				PLC.BCP-4				
BP-YI-4659	Blower 4 Motor Heater Run Status	I-PID-1	DI			PLC.BCP-4	Blower 4 Motor Heater				PLC.BCP-4				
BP-UA-4659	Blower 4 Motor Heater Fault	I-PID-1	DI			PLC.BCP-4	Blower 4 Motor Heater				PLC.BCP-4				
BP-LAL-4660	Blower 4 Lube Oil Reservoir Low Level Switch	I-PID-2	DI			PLC.BCP-4	LSL-4660				PLC.BCP-4				
BP-LALL-4660	Blower 4 Lube Oil Reservoir Low Low Level Switch	I-PID-2	DI			PLC.BCP-4	LSLL-4660				PLC.BCP-4				
BP-TI-4660	Blower 4 Lube Oil Reservoir Temperature	I-PID-2	AI			PLC.BCP-4	TIT-4660				PLC.BCP-4				
BP-HS-4661	Blower 4 Lube Oil Aux. Pump Start Command	I-PID-2	DO			MCC	HS-4661				PLC.BCP-4				
BP-YI-4661	Blower 4 Lube Oil Aux. Pump Running Status	I-PID-2	DI			MCC	YIL-4661				PLC.BCP-4				
BP-XI-4661	Blower 4 Lube Oil Aux. Pump Overload	I-PID-2	DI			MCC	XI-4661				PLC.BCP-4				
BP-HS-4662	Blower 4 Lube Oil Reservoir Immersion Heater Energize Command	I-PID-2	DO			MCC	XS-4662				PLC.BCP-4				
BP-YI-4662	Blower 4 Lube Oil Reservoir Immersion Heater Run Status	I-PID-2	DI			MCC	YIL-4662				PLC.BCP-4				
BP-UA-4662	Blower 4 Lube Oil Reservoir Immersion Heater Fault	I-PID-2	DI			MCC	XI-4662				PLC.BCP-4				
BP-TAL-4660	Blower 4 Lube Oil Reservoir Temperature Switch Low	I-PID-2	DI			PLC.BCP-4	TSL-4660				PLC.BCP-4				
BP-HS-4663	Blower 4 Lube Oil Heat Exchanger Cooling Water Return Valve Open Command	I-PID-2	DO			PLC.BCP-4	SOV-4663				PLC.BCP-4				
BP-ZI-4663O	Blower 4 Lube Oil Heat Exchanger Cooling Water Return Valve Opened	I-PID-2	DI			PLC.BCP-4	ZSO-4663				PLC.BCP-4				
BP-ZI-4663C	Blower 4 Lube Oil Heat Exchanger Cooling Water Return Valve Closed	I-PID-2	DI			PLC.BCP-4	ZSC-4663				PLC.BCP-4				
BP-TC-4664	Blower 4 Lube Oil Temperature Control	I-PID-2	AO			PLC.BCP-4	TCV-4664				PLC.BCP-4				
BP-PDI-4665	Blower 4 Lube Oil Filter Differential Pressure High	I-PID-2	DI			PLC.BCP-4	PDSH-4665				PLC.BCP-4				

BLOWER 4 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
BP-PC-4666	Blower 4 Lube Oil Pressure Control	I-PID-2	AO			PLC.BCP-4	PCV-4666				PLC.BCP-4				
BP-PI-4667	Blower 4 Lube Oil Supply Pressure	I-PID-2	AI			PLC.BCP-4	PIT-4667				PLC.BCP-4				
BP-TI-4667	Blower 4 Lube Oil Supply Temperature	I-PID-2	AI			PLC.BCP-4	TIT-4667				PLC.BCP-4				
BP-HS-4668	Blower 4 Lube Oil Reservoir Mist Filter Run Command	I-PID-2	DO			PLC.BCP-4	HS-4668				PLC.BCP-4				
BP-YI-4668	Blower 4 Lube Oil Reservoir Mist Filter Run Status	I-PID-2	DI			PLC.BCP-4	YIL-4668				PLC.BCP-4				
BP-UA-4668	Blower 4 Lube Oil Reservoir Mist Filter Fault	I-PID-2	DI			PLC.BCP-4	XI-4668				PLC.BCP-4				
BP-UA-4668A	Blower 4 Local Control Panel PLC System Malfunction	I-PID-2	DI			PLC.BCP-4	PLC.BCP-4				PLC.BCP-4				
BP-UA-4668B	Blower 4 Local Control Panel Low PLC Battery	I-PID-2	DI			PLC.BCP-4	PLC.BCP-4				PLC.BCP-4				
BP-UA-4669A	Aeration Control Panel PLC System Malfunction	I-PID-2	DI			PLC.BCP-4	PLC.BCP-4				PLC.BCP-4				
BP-UA-4669B	Aeration Control Panel Low PLC Battery	I-PID-2	DI			PLC.BCP-4	PLC.BCP-4				PLC.BCP-4				
BP-YA-4669C	Aeration Control Panel Alarm Horn	I-PID-2	DO			PLC.BCP-4	PLC.BCP-4				PLC.BCP-4				
BP-YA-4669D	Aeration Control Panel Alarm Strobe	I-PID-2	DO			PLC.BCP-4	PLC.BCP-4				PLC.BCP-4				
BP-PDI-4670	Blower 4 Low Lube Oil Pressure Low	I-PID-2	DI			PLC.BCP-4	PSL-4670				PLC.BCP-4				

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
SOUTH SHORE BLOWER LOCAL CONTROL PANEL															
BP-PDI-4701A	Blower 5 Inlet Filter 1st Stage Differential Pressure High	I-PID-1	DI			PLC.BCP-5	PDSH-4701A				PLC.BCP-5				
BP-PDI-4701B	Blower 5 Inlet Filter 2nd Stage Differential Pressure High	I-PID-1	DI			PLC.BCP-5	PDSH-4701B				PLC.BCP-5				
BP-TI-4701	Blower 5 Inlet Temperature	I-PID-1	AI			PLC.BCP-5	TIT-4701				PLC.BCP-5				
BP-PI-4701	Blower 5 Inlet Pressure	I-PID-1	AI			PLC.BCP-5	PIT-4701				PLC.BCP-5				
BP-PI-4702	Blower 5 Discharge Pressure	I-PID-1	AI			PLC.BCP-5	PIT-4702				PLC.BCP-5				
BP-TI-4702	Blower 5 Discharge Temperature	I-PID-1	AI			PLC.BCP-5	TIT-4702				PLC.BCP-5				
BP-PDI-4702	Blower 5 Inlet/Outlet Differential Pressure	I-PID-1	AI			PLC.BCP-5	PDIT-4702				PLC.BCP-5				
BP-ZC-4701	Blower 5 Discharge Valve Position Command	I-PID-1	AO			PLC.BCP-5	PDV-4701				PLC.BCP-5				
BP-ZI-4701O	Blower 5 Discharge Valve Opened	I-PID-1	DI			PLC.BCP-5	ZSO-4701				PLC.BCP-5				
BP-ZI-4701C	Blower 5 Discharge Valve Closed	I-PID-1	DI			PLC.BCP-5	ZSC-4701				PLC.BCP-5				
BP-ZI-4701	Blower 5 Discharge Valve Position	I-PID-1	AI			PLC.BCP-5	ZIT-4701				PLC.BCP-5				
BP-UA-4701	Blower 5 Discharge Valve Fault	I-PID-1	DI			PLC.BCP-5	XI-4701				PLC.BCP-5				
BP-HS-4701A	Blower 5 Discharge Valve Local/Remote	I-PID-1	DI			PLC.BCP-5	HS-4701A				PLC.BCP-5				
BP-HS-4701B	Blower 5 Discharge Valve Open/Stop/Close	I-PID-1	DI			PLC.BCP-5	HS-4701B				PLC.BCP-5				
BP-ZC-4702	Blower 5 Blow-Off Valve Position Command	I-PID-1	AO			PLC.BCP-5	BV-4702				PLC.BCP-5				
BP-ZI-4702O	Blower 5 Blow-Off Valve Opened	I-PID-1	DI			PLC.BCP-5	ZSO-4702				PLC.BCP-5				
BP-ZI-4702C	Blower 5 Blow-Off Valve Closed	I-PID-1	DI			PLC.BCP-5	ZSC-4702				PLC.BCP-5				
BP-ZI-4702	Blower 5 Blow-Off Valve Position	I-PID-1	AI			PLC.BCP-5	ZIT-4702				PLC.BCP-5				
BP-UA-4702	Blower 5 Blow-Off Valve Fault	I-PID-1	DI			PLC.BCP-5	XI-4702				PLC.BCP-5				
BP-HS-4702A	Blower 5 Blow-Off Valve Local/Remote	I-PID-1	DI			PLC.BCP-5	HS-4702A				PLC.BCP-5				
BP-HS-4702B	Blower 5 Blow-Off Valve Open/Stop/Close	I-PID-1	DI			PLC.BCP-5	HS-4702B				PLC.BCP-5				
BP-YA-4703	Blower 5 Emergency Stop	I-PID-1	DI			PLC.BCP-5	PLC.BCP-5				PLC.BCP-5				
BP-HR-4703	Blower 5 Motor Start Command	I-PID-1	DO			MCC	MCC				PLC.BCP-5				
BP-YI-4703	Blower 5 Motor Run Status	I-PID-1	DI			MCC	MCC				PLC.BCP-5				
BP-UA-4703	Blower 5 Motor Fault	I-PID-1	DI			MCC	MCC				PLC.BCP-5				
BP-IT-4703	Blower 5 Motor Current	I-PID-1	AI			MCC	MCC				PLC.BCP-5				
BP-VI-4703X	Blower 5 Motor X-Axis Vibration	I-PID-1	AI			PLC.BCP-5	VE-4703X				PLC.BCP-5				
BP-VI-4703Y	Blower 5 Motor Y-Axis Vibration	I-PID-1	AI			PLC.BCP-5	VE-4703Y				PLC.BCP-5				
BP-VI-4703Z	Blower 5 Motor Z-Axis Vibration	I-PID-1	AI			PLC.BCP-5	VE-4703Z				PLC.BCP-5				
BP-TI-4703A	Blower 5 Motor Phase A Winding Temperature	I-PID-1	AI			PLC.BCP-5	TE-4703A				PLC.BCP-5				
BP-TI-4703B	Blower 5 Motor Phase B Winding Temperature	I-PID-1	AI			PLC.BCP-5	TE-4703B				PLC.BCP-5				
BP-TI-4703C	Blower 5 Motor Phase C Winding Temperature	I-PID-1	AI			PLC.BCP-5	TE-4703C				PLC.BCP-5				
BP-TI-4703D	Blower 5 Motor Non-Drive End Temperature	I-PID-1	AI			PLC.BCP-5	TE-4703D				PLC.BCP-5				
BP-TI-4703E	Blower 5 Motor Drive End Temperature	I-PID-1	AI			PLC.BCP-5	TE-4703E				PLC.BCP-5				
BP-ZC-4704	Blower 5 Inlet Guide Vanes Position Command	I-PID-1	AO			PLC.BCP-5	ZC-4704				PLC.BCP-5				
BP-ZI-4704	Blower 5 Inlet Guide Vanes Position Feedback	I-PID-1	AI			PLC.BCP-5	ZIT-4704				PLC.BCP-5				

BLOWER 5 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
BP-ZI-4704O	Blower 5 Inlet Guide Vanes Opened	I-PID-1	DI			PLC.BCP-5	ZSO-4704				PLC.BCP-5				
BP-ZI-4704C	Blower 5 Inlet Guide Vanes Closed	I-PID-1	DI			PLC.BCP-5	ZSC-4704				PLC.BCP-5				
BP-ZC-4705	Blower 5 Variable Diffuser Position Command	I-PID-1	AO			PLC.BCP-5	ZC-4705				PLC.BCP-5				
BP-ZI-4705	Blower 5 Variable Diffuser Position Feedback	I-PID-1	AI			PLC.BCP-5	ZIT-4705				PLC.BCP-5				
BP-ZI-4705O	Blower 5 Variable Diffuser Opened	I-PID-1	DI			PLC.BCP-5	ZSO-4705				PLC.BCP-5				
BP-ZI-4705C	Blower 5 Variable Diffuser Closed	I-PID-1	DI			PLC.BCP-5	ZSC-4705				PLC.BCP-5				
BP-TI-4706A	Blower 5 Gearbox Temperature A	I-PID-1	AI			PLC.BCP-5	TE-4706A				PLC.BCP-5				
BP-TI-4706B	Blower 5 Gearbox Temperature B	I-PID-1	AI			PLC.BCP-5	TE-4706B				PLC.BCP-5				
BP-TI-4706C	Blower 5 Gearbox Temperature C	I-PID-1	AI			PLC.BCP-5	TE-4706C				PLC.BCP-5				
BP-TI-4706D	Blower 5 Gearbox Temperature D	I-PID-1	AI			PLC.BCP-5	TE-4706D				PLC.BCP-5				
BP-VI-4706A	Blower 5 Gearbox Vibration A Sensor	I-PID-1	AI			PLC.BCP-5	VE-4706A				PLC.BCP-5				
BP-VI-4706B	Blower 5 Gearbox Vibration B Sensor	I-PID-1	AI			PLC.BCP-5	VE-4706B				PLC.BCP-5				
BP-VI-4706C	Blower 5 Gearbox Vibration C Sensor	I-PID-1	AI			PLC.BCP-5	VE-4706C				PLC.BCP-5				
BP-VI-4706D	Blower 5 Gearbox Vibration D Sensor	I-PID-1	AI			PLC.BCP-5	VE-4706D				PLC.BCP-5				
BP-VI-4706E	Blower 5 Gearbox Vibration E Sensor	I-PID-1	AI			PLC.BCP-5	VE-4706E				PLC.BCP-5				
BP-VI-4706F	Blower 5 Gearbox Vibration F Sensor	I-PID-1	AI			PLC.BCP-5	VE-4706F				PLC.BCP-5				
BP-TI-4707	Blower 5 Discharge Expansion Cone Temperature	I-PID-1	AI			PLC.BCP-5	TIT-4707				PLC.BCP-5				
BP-SI-4708	Blower 5 Zero Speed Switch	I-PID-1	DI			PLC.BCP-5	SS-4708				PLC.BCP-5				
BP-HS-4709	Blower 5 Motor Heater Energize	I-PID-1	DO			PLC.BCP-5	Blower 5 Motor Heater				PLC.BCP-5				
BP-YI-4709	Blower 5 Motor Heater Run Status	I-PID-1	DI			PLC.BCP-5	Blower 5 Motor Heater				PLC.BCP-5				
BP-UA-4709	Blower 5 Motor Heater Fault	I-PID-1	DI			PLC.BCP-5	Blower 5 Motor Heater				PLC.BCP-5				
BP-LAL-4710	Blower 5 Lube Oil Reservoir Low Level Switch	I-PID-2	DI			PLC.BCP-5	LSL-4710				PLC.BCP-5				
BP-LALL-4710	Blower 5 Lube Oil Reservoir Low Low Level Switch	I-PID-2	DI			PLC.BCP-5	LSLL-4710				PLC.BCP-5				
BP-TI-4710	Blower 5 Lube Oil Reservoir Temperature	I-PID-2	AI			PLC.BCP-5	TIT-4710				PLC.BCP-5				
BP-HS-4711	Blower 5 Lube Oil Aux. Pump Start Command	I-PID-2	DO			MCC	HS-4711				PLC.BCP-5				
BP-YI-4711	Blower 5 Lube Oil Aux. Pump Running Status	I-PID-2	DI			MCC	YIL-4711				PLC.BCP-5				
BP-XI-4711	Blower 5 Lube Oil Aux. Pump Overload	I-PID-2	DI			MCC	XI-4711				PLC.BCP-5				
BP-HS-4712	Blower 5 Lube Oil Reservoir Immersion Heater Energize Command	I-PID-2	DO			MCC	XS-4712				PLC.BCP-5				
BP-YI-4712	Blower 5 Lube Oil Reservoir Immersion Heater Run Status	I-PID-2	DI			MCC	YIL-4712				PLC.BCP-5				
BP-UA-4712	Blower 5 Lube Oil Reservoir Immersion Heater Fault	I-PID-2	DI			MCC	XI-4712				PLC.BCP-5				
BP-TAL-4710	Blower 5 Lube Oil Reservoir Temperature Switch Low	I-PID-2	DI			PLC.BCP-5	TSL-4710				PLC.BCP-5				
BP-HS-4713	Blower 5 Lube Oil Heat Exchanger Cooling Water Return Valve Open Command	I-PID-2	DO			PLC.BCP-5	SOV-4713				PLC.BCP-5				
BP-ZI-4713O	Blower 5 Lube Oil Heat Exchanger Cooling Water Return Valve Opened	I-PID-2	DI			PLC.BCP-5	ZSO-4713				PLC.BCP-5				
BP-ZI-4713C	Blower 5 Lube Oil Heat Exchanger Cooling Water Return Valve Closed	I-PID-2	DI			PLC.BCP-5	ZSC-4713				PLC.BCP-5				
BP-TC-4714	Blower 5 Lube Oil Temperature Control	I-PID-2	AO			PLC.BCP-5	TCV-4714				PLC.BCP-5				
BP-PDI-4715	Blower 5 Lube Oil Filter Differential Pressure High	I-PID-2	DI			PLC.BCP-5	PDSH-4715				PLC.BCP-5				

BLOWER 5 INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS
							DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #	
BP-PC-4716	Blower 5 Lube Oil Pressure Control	I-PID-2	AO			PLC.BCP-5	PCV-4716				PLC.BCP-5				
BP-PI-4717	Blower 5 Lube Oil Supply Pressure	I-PID-2	AI			PLC.BCP-5	PIT-4717				PLC.BCP-5				
BP-TI-4717	Blower 5 Lube Oil Supply Temperature	I-PID-2	AI			PLC.BCP-5	TIT-4717				PLC.BCP-5				
BP-HS-4718	Blower 5 Lube Oil Reservoir Mist Filter Run Command	I-PID-2	DO			PLC.BCP-5	HS-4718				PLC.BCP-5				
BP-YI-4718	Blower 5 Lube Oil Reservoir Mist Filter Run Status	I-PID-2	DI			PLC.BCP-5	YIL-4718				PLC.BCP-5				
BP-UA-4718	Blower 5 Lube Oil Reservoir Mist Filter Fault	I-PID-2	DI			PLC.BCP-5	XI-4718				PLC.BCP-5				
BP-UA-4718A	Blower 5 Local Control Panel PLC System Malfunction	I-PID-2	DI			PLC.BCP-5	PLC.BCP-5				PLC.BCP-5				
BP-UA-4718B	Blower 5 Local Control Panel Low PLC Battery	I-PID-2	DI			PLC.BCP-5	PLC.BCP-5				PLC.BCP-5				
BP-UA-4719A	Aeration Control Panel PLC System Malfunction	I-PID-2	DI			PLC.BCP-5	PLC.BCP-5				PLC.BCP-5				
BP-UA-4719B	Aeration Control Panel Low PLC Battery	I-PID-2	DI			PLC.BCP-5	PLC.BCP-5				PLC.BCP-5				
BP-YA-4719C	Aeration Control Panel Alarm Horn	I-PID-2	DO			PLC.BCP-5	PLC.BCP-5				PLC.BCP-5				
BP-YA-4719D	Aeration Control Panel Alarm Strobe	I-PID-2	DO			PLC.BCP-5	PLC.BCP-5				PLC.BCP-5				
BP-PDI-4720	Blower 5 Lube Oil Pressure Low Pressure	I-PID-2	DI			PLC.BCP-5	PSL-4720				PLC.BCP-5				

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	ETHERNET PROTOCOL	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS	OIT Dsiplay	OIT Trend	SCADA Display	SCADA Historical Data Log	OIT/SCADA Alarm
								DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #						
	Exhaust Fan 1 Running	H-DG-2	DI					EFCP-1				PLC-HVAC-ABF					Y		Y	Y	
	Exhaust Fan 1 Fault	H-DG-2	DI					EFCP-1				PLC-HVAC-ABF					Y	Y	Y	Y	Y
	Exhaust Fan 2 Running	H-DG-2	DI					EFCP-1				PLC-HVAC-ABF					Y		Y	Y	
	Exhaust Fan 2 Fault	H-DG-2	DI					EFCP-1				PLC-HVAC-ABF					Y	Y	Y	Y	Y
	Exhaust Fan 3 Running	H-DG-2	DI					EFCP-1				PLC-HVAC-ABF					Y		Y	Y	
	Exhaust Fan 3 Fault	H-DG-2	DI					EFCP-1				PLC-HVAC-ABF					Y	Y	Y	Y	Y
	Exhaust Fan 4 Running	H-DG-2	DI					EFCP-1				PLC-HVAC-ABF					Y		Y	Y	
	Exhaust Fan 4 Fault	H-DG-2	DI					EFCP-1				PLC-HVAC-ABF					Y	Y	Y	Y	Y
	Exhaust Fan 5 Running	H-DG-2	DI					EFCP-1				PLC-HVAC-ABF					Y		Y	Y	
	Exhaust Fan 5 Fault	H-DG-2	DI					EFCP-1				PLC-HVAC-ABF					Y	Y	Y	Y	Y
	Exhaust Fan 6 Running	H-DG-2	DI					AMP-1				PLC-HVAC-ABF					Y		Y	Y	
	Exhaust Fan 6 Fault	H-DG-2	DI					AMP-1				PLC-HVAC-ABF					Y	Y	Y	Y	Y
	Exhaust Fan 7 Running	H-DG-2	DI					AMP-1				PLC-HVAC-ABF					Y		Y	Y	
	Exhaust Fan 7 Fault	H-DG-2	DI					AMP-1				PLC-HVAC-ABF					Y	Y	Y	Y	Y
	Exhaust Fan 8 Running	H-DG-2	DI					AMP-1				PLC-HVAC-ABF					Y		Y	Y	
	Exhaust Fan 8 Fault	H-DG-2	DI					AMP-1				PLC-HVAC-ABF					Y	Y	Y	Y	Y
	Low Building Temperature Alarm	H-DG-3	DI					HCP-1				PLC-HVAC-ABF					Y	Y	Y	Y	Y
	Heat Trace General Alarm	H-DG-3	DI					Heat Trace Controller				PLC-HVAC-ABF					Y	Y	Y	Y	Y
	Battery Hydrogen Alarm	H-DG-3	DI					Battery Hydrogen Transmitter				PLC-HVAC-ABF					Y	Y	Y	Y	Y
	MES-HVAC-ABF Connection Loss	I-DG-1	DI	SNMP				MES-HVAC-ABF				SCADA VIA MES-HVAC-ABF							Y	Y	Y
	FOCE-ABF Connection Loss	I-DG-1	DI	SNMP				MES-HVAC-ABF				SCADA VIA MES-HVAC-ABF							Y	Y	Y
	UPS-FOCE-ABF Input Frequency Failure	I-DG-1	DI	SNMP				UPS-HVAC-ABF				SCADA VIA FOCE-ABF					Y		Y	Y	Y
	UPS-FOCE-ABF Input Blackout	I-DG-1	DI	SNMP				UPS-HVAC-ABF				SCADA VIA FOCE-ABF					Y		Y	Y	Y
	UPS-FOCE-ABF Low Battery	I-DG-1	DI	SNMP				UPS-HVAC-ABF				SCADA VIA FOCE-ABF					Y		Y	Y	Y
	UPS-FOCE-ABF On Battery	I-DG-1	DI	SNMP				UPS-HVAC-ABF				SCADA VIA FOCE-ABF					Y		Y	Y	Y
	UPS-FOCE-ABF On Bypass	I-DG-1	DI	SNMP				UPS-HVAC-ABF				SCADA VIA FOCE-ABF					Y		Y	Y	Y
	UPS-FOCE-ABF Output Off	I-DG-1	DI	SNMP				UPS-HVAC-ABF				SCADA VIA FOCE-ABF					Y		Y	Y	Y
	UPS-FOCE-ABF Over Voltage	I-DG-1	DI	SNMP				UPS-HVAC-ABF				SCADA VIA FOCE-ABF					Y		Y	Y	Y
	UPS-FOCE-ABF Overload	I-DG-1	DI	SNMP				UPS-HVAC-ABF				SCADA VIA FOCE-ABF					Y		Y	Y	Y
	UPS-FOCE-ABF Under Voltage	I-DG-1	DI	SNMP				UPS-HVAC-ABF				SCADA VIA FOCE-ABF					Y		Y	Y	Y
	UPS-ABF-HVAC Input Frequency Failure	I-DG-1	DI	Modbus/TCP				UPS-HVAC-ABF				SCADA VIA MES-HVAC-ABF					Y		Y	Y	Y
	UPS-ABF-HVAC Input Blackout	I-DG-1	DI	Modbus/TCP				UPS-HVAC-ABF				SCADA VIA MES-HVAC-ABF					Y		Y	Y	Y
	UPS-ABF-HVAC Low Battery	I-DG-1	DI	Modbus/TCP				UPS-HVAC-ABF				SCADA VIA MES-HVAC-ABF					Y		Y	Y	Y
	UPS-ABF-HVAC On Battery	I-DG-1	DI	Modbus/TCP				UPS-HVAC-ABF				SCADA VIA MES-HVAC-ABF					Y		Y	Y	Y
	UPS-ABF-HVAC On Bypass	I-DG-1	DI	Modbus/TCP				UPS-HVAC-ABF				SCADA VIA MES-HVAC-ABF					Y		Y	Y	Y
	UPS-ABF-HVAC Output Off	I-DG-1	DI	Modbus/TCP				UPS-HVAC-ABF				SCADA VIA MES-HVAC-ABF					Y		Y	Y	Y
	UPS-ABF-HVAC Over Voltage	I-DG-1	DI	Modbus/TCP				UPS-HVAC-ABF				SCADA VIA MES-HVAC-ABF					Y		Y	Y	Y
	UPS-ABF-HVAC Overload	I-DG-1	DI	Modbus/TCP				UPS-HVAC-ABF				SCADA VIA MES-HVAC-ABF					Y		Y	Y	Y
	UPS-ABF-HVAC Under Voltage	I-DG-1	DI	Modbus/TCP				UPS-HVAC-ABF				SCADA VIA MES-HVAC-ABF					Y		Y	Y	Y
BP-II-2600A	MVABP-A07 Main Breaker Amps Phase A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2600B	MVABP-A07 Main Breaker Amps Phase B	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2600C	MVABP-A07 Main Breaker Amps Phase C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2600A	MVABP-A07 Main Breaker Volts Phase B-C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	ETHERNET PROTOCOL	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS	OIT Dsiplay	OIT Trend	SCADA Display	SCADA Historical Data Log	OIT/SCADA Alarm
								DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #						
BP-EI-2600B	MVABP-A07 Main Breaker Volts Phase C-A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2600C	MVABP-A07 Main Breaker Power Factor	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2600	MVABP-A07 Main Breaker Real Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2601	MVABP-A07 Main Breaker Apparent Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2602	MVABP-A07 Main Breaker Maximum Real Demand (kW)	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2603C	MVABP-A07 Main Breaker Closed	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2603O	MVABP-A07 Main Breaker Open	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-UA-2603O	MVABP-A07 Main Breaker Tripped	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
BP-II-2604A	MVABP-B07 Main Breaker Amps Phase A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604B	MVABP-B07 Main Breaker Amps Phase B	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604C	MVABP-B07 Main Breaker Amps Phase C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604A	MVABP-B07 Main Breaker Voltas Phase B-C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604B	MVABP-B07 Main Breaker Volts Phase C-A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604C	MVABP-B07 Main Breaker Power Factor	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2604	MVABP-B07 Main Breaker Real Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2605	MVABP-B07 Main Breaker Apparent Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2606	MVABP-B07 Main Breaker Maximum Real Demand (kW)	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606C	MVABP-B07 Main Breaker Closed	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606O	MVABP-B07 Main Breaker Open	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-UA-2606O	MVABP-B07 Main Breaker Tripped	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
BP-II-2604A	MVABP Tie Breaker Amps Phase A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604B	MVABP Tie Breaker Amps Phase B	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604C	MVABP Tie Breaker Amps Phase C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604A	MVABP Tie Breaker Voltas Phase B-C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604B	MVABP Tie Breaker Volts Phase C-A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604C	MVABP Tie Breaker Power Factor	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2604	MVABP Tie Breaker Real Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2605	MVABP Tie Breaker Apparent Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2606	MVABP Tie Breaker Maximum Real Demand (kW)	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606C	MVABP Tie Breaker Closed	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606O	MVABP Tie Breaker Open	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-UA-2606O	MVABP Tie Breaker Tripped	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
BP-II-2604A	HHWS1 Breaker Amps Phase A	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604B	HHWS1 Breaker Amps Phase B	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604C	HHWS1 Breaker Amps Phase C	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604A	HHWS1 Breaker Voltas Phase B-C	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604B	HHWS1 Breaker Volts Phase C-A	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604C	HHWS1 Breaker Power Factor	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2604	HHWS1 Breaker Real Power	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2605	HHWS1 Breaker Apparent Power	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2606	HHWS1 Breaker Maximum Real Demand (kW)	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606C	HHWS1 Breaker Closed	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606O	HHWS1 Breaker Open	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-UA-2606O	HHWS1 Breaker Tripped	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
BP-II-2604A	HHWS2 Breaker Amps Phase A	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	ETHERNET PROTOCOL	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS	OIT Dsiplay	OIT Trend	SCADA Display	SCADA Historical Data Log	OIT/SCADA Alarm
								DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #						
BP-II-2604B	HHWS2 Breaker Amps Phase B	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604C	HHWS2 Breaker Amps Phase C	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604A	HHWS2 Breaker Voltas Phase B-C	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604B	HHWS2 Breaker Volts Phase C-A	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604C	HHWS2 Breaker Power Factor	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2604	HHWS2 Breaker Real Power	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2605	HHWS2 Breaker Apparent Power	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2606	HHWS2 Breaker Maximum Real Demand (kW)	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606C	HHWS2 Breaker Closed	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606O	HHWS2 Breaker Open	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-UA-2606O	HHWS2 Breaker Tripped	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
BP-II-2604A	HHWS3 Breaker Amps Phase A	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604B	HHWS3 Breaker Amps Phase B	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604C	HHWS3 Breaker Amps Phase C	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604A	HHWS3 Breaker Voltas Phase B-C	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604B	HHWS3 Breaker Volts Phase C-A	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604C	HHWS3 Breaker Power Factor	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2604	HHWS3 Breaker Real Power	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2605	HHWS3 Breaker Apparent Power	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2606	HHWS3 Breaker Maximum Real Demand (kW)	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606C	HHWS3 Breaker Closed	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606O	HHWS3 Breaker Open	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-UA-2606O	HHWS3 Breaker Tripped	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
BP-II-2604A	HHWS4 Breaker Amps Phase A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604B	HHWS4 Breaker Amps Phase B	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604C	HHWS4 Breaker Amps Phase C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604A	HHWS4 Breaker Voltas Phase B-C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604B	HHWS4 Breaker Volts Phase C-A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604C	HHWS4 Breaker Power Factor	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2604	HHWS4 Breaker Real Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2605	HHWS4 Breaker Apparent Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2606	HHWS4 Breaker Maximum Real Demand (kW)	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606C	HHWS4 Breaker Closed	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606O	HHWS4 Breaker Open	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-UA-2606O	HHWS4 Breaker Tripped	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
BP-II-2604A	HHWS5 Breaker Amps Phase A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604B	HHWS5 Breaker Amps Phase B	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604C	HHWS5 Breaker Amps Phase C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604A	HHWS5 Breaker Voltas Phase B-C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604B	HHWS5 Breaker Volts Phase C-A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604C	HHWS5 Breaker Power Factor	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2604	HHWS5 Breaker Real Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2605	HHWS5 Breaker Apparent Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2606	HHWS5 Breaker Maximum Real Demand (kW)	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606C	HHWS5 Breaker Closed	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606O	HHWS5 Breaker Open	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	ETHERNET PROTOCOL	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS	OIT Dsiplay	OIT Trend	SCADA Display	SCADA Historical Data Log	OIT/SCADA Alarm
								DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #						
BP-UA-2606O	HHWS5 Breaker Tripped	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
BP-II-2604A	TR-A4 Breaker Amps Phase A	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604B	TR-A4 Breaker Amps Phase B	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604C	TR-A4 Breaker Amps Phase C	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604A	TR-A4 Breaker Voltas Phase B-C	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604B	TR-A4 Breaker Volts Phase C-A	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604C	TR-A4 Breaker Power Factor	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2604	TR-A4 Breaker Real Power	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2605	TR-A4 Breaker Apparent Power	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2606	TR-A4 Breaker Maximum Real Demand (kW)	E-DG-1	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606C	TR-A4 Breaker Closed	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606O	TR-A4 Breaker Open	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-UA-2606O	TR-A4 Breaker Tripped	E-DG-1	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
BP-II-2604A	TR-B4 Breaker Amps Phase A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604B	TR-B4 Breaker Amps Phase B	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604C	TR-B4 Breaker Amps Phase C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604A	TR-B4 Breaker Voltas Phase B-C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604B	TR-B4 Breaker Volts Phase C-A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604C	TR-B4 Breaker Power Factor	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2604	TR-B4 Breaker Real Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2605	TR-B4 Breaker Apparent Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2606	TR-B4 Breaker Maximum Real Demand (kW)	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606C	TR-B4 Breaker Closed	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606O	TR-B4 Breaker Open	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-UA-2606O	TR-B4 Breaker Tripped	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
BP-II-2604A	LVABP-MCC-A Main Breaker Amps Phase A	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604B	LVABP-MCC-A Main Breaker Amps Phase B	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-II-2604C	LVABP-MCC-A Main Breaker Amps Phase C	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604A	LVABP-MCC-A Main Breaker Voltas Phase B-C	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604B	LVABP-MCC-A Main Breaker Volts Phase C-A	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-EI-2604C	LVABP-MCC-A Main Breaker Power Factor	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2604	LVABP-MCC-A Main Breaker Real Power	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2605	LVABP-MCC-A Main Breaker Apparent Power	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-JI-2606	LVABP-MCC-A Main Breaker Maximum Real Demand (kW)	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606C	LVABP-MCC-A Main Breaker Closed	E-DG-4	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-YZ-2606O	LVABP-MCC-A Main Breaker Open	E-DG-4	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
BP-UA-2606O	LVABP-MCC-A Main Breaker Tripped	E-DG-4	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
	LVABP-MCC-B Main Breaker Amps Phase A	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP-MCC-B Main Breaker Amps Phase B	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP-MCC-B Main Breaker Amps Phase C	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP-MCC-B Main Breaker Voltas Phase B-C	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP-MCC-B Main Breaker Volts Phase C-A	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP-MCC-B Main Breaker Power Factor	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP-MCC-B Main Breaker Real Power	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP-MCC-B Main Breaker Apparent Power	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	ETHERNET PROTOCOL	RANGE /SETPOINT	UNITS	POWER FROM	SIGNAL FROM				SIGNAL TO				PLC ADDRESS	OIT Dsiplay	OIT Trend	SCADA Display	SCADA Historical Data Log	OIT/SCADA Alarm
								DEVICE	TB	TERMINAL #	TERMINAL #	DEVICE	TB	TERMINAL #	TERMINAL #						
	LVABP-MCC-B Main Breaker Maximum Real Demand (kW)	E-DG-4	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP-MCC-B Main Breaker Closed	E-DG-4	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP-MCC-B Main Breaker Open	E-DG-4	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP-MCC-B Main Breaker Tripped	E-DG-4	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
	LVABP Tie Breaker Amps Phase A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP Tie Breaker Amps Phase B	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP Tie Breaker Amps Phase C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP Tie Breaker Voltas Phase B-C	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP Tie Breaker Volts Phase C-A	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP Tie Breaker Power Factor	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP Tie Breaker Real Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP Tie Breaker Apparent Power	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP Tie Breaker Maximum Real Demand (kW)	E-DG-3	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP Tie Breaker Closed	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP Tie Breaker Open	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVABP Tie Breaker Tripped	E-DG-3	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y
	LVP-1 Breaker Amps Phase A	E-DG-5	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVP-1 Breaker Amps Phase B	E-DG-5	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVP-1 Breaker Amps Phase C	E-DG-5	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVP-1 Breaker Voltas Phase B-C	E-DG-5	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVP-1 Breaker Volts Phase C-A	E-DG-5	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVP-1 Breaker Power Factor	E-DG-5	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVP-1 Breaker Real Power	E-DG-5	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVP-1 Breaker Apparent Power	E-DG-5	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVP-1 Breaker Maximum Real Demand (kW)	E-DG-5	AI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVP-1 Breaker Closed	E-DG-5	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVP-1 Breaker Open	E-DG-5	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	
	LVP-1 Breaker Tripped	E-DG-5	DI	Modbus/TCP				Mimic Panel				SCADA VIA FOCE-ABF							Y	Y	Y

NO TEXT ON THIS PAGE

SECTION 13491

PROCESS CONTROL DESCRIPTIONS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:

1. Programming of the PLCs and configuration of Operator Interface Terminals (OIT) software is part of this Contract. Control strategies provided in this Section are for general information.

2. The PLC programs and configured OIT software will be uploaded to the appropriate PLCs and computers at panel shop before the Factory Test, specified in Section 13402, Process Control System Factory Testing.

3. Programming the required control strategies in processors located within the control panels that are provided with package systems is part of this Contract. Programming the processors, testing, and start-up of the package systems are the responsibility of the package system suppliers, the Applications Engineering Services Supplier (AESS) and the Contractor.

    a. AESS scope is defined in Section 13306 Application Engineering Services.

B. Related Sections:
1. Section 11610, Integrally Geared Single Stage Centrifugal Blowers
2. Section 13306, Applications Engineering Services
3. Section 13401, Process Control System General Provisions.
4. Section 13402, Process Control System Factory Testing.
5. Section 13403, Process Control System Start-Up and Field Testing
6. Section 13404, Process Control System Training
7. Section 13451, PLC Hardware and Software
8. Section 13480, Input Output Point List
9. Section 13570, Control Criteria

C. This Section describes all the anticipated control programming under this Contract. The control strategies are generally divided by the responsible supplier and further subdivided by panel.

D. Process Control Functions:

1. Process control function shall be structured to permit the realization of all control strategy requirements. In addition, each control function shall be designed so that balance free transfers are obtained during operating mode changeover and initialization. Where applicable, user-changeable parameters shall be automatically defaulted to a preset value if a specific value is not given during system generation.

2. The P&IDs represent the required process monitoring and control. The required control for the system is a combination of the representation on the P&IDs and the requirements specified herein. The P&IDs do not show all the required internal diagnostic indications. In addition, to the indications shown on the P&IDs the following, at a minimum shall be provided:

    a. Indication of bad quality on any hard-wired input/output point (such as less than 3.5 milliamps on a 4 to 20 mADC circuit).

    b. Individual PLC fault indications.

    c. Indication of a communications failure.

    d. Indication of Input/Output module failure.

    e. Indication of an Input/Output channel failure.

    f. For all motor start and stop commands check for run feedback after adjustable time delay (0 to 30 seconds). Provide a “FAIL TO START” and “FAIL TO STOP” alarm if unit fails to run or stop. Use the bad start or stop bit to remove the run command from the control logic.

    g. For analog control loops, when control of field equipment is not in “COMPUTER,” the associated PID controller output shall track the position feedback.

    h. Runtimes shall be provided for all pieces of equipment. Runtimes shall be seven digits long and reset back to zero when it reaches the maximum number. Runtimes shall maintain the latest values during power outage.

    i. For all analog signals, provide the following alarm indications:
        (1) “High-high.”
        (2) “High.”
        (3) “Low.”
        (4) “Low-low.”
        (5) “High and low rate of change.”

3. In addition to the indications shown on the P&IDs, the following shall be provided at a minimum:

   a. Analog Data Scaling: This control function shall scale all analog inputs to a common span and shall normalize the digital representation of each analog input to a percentage of the operating span. The processed value shall be expressed as a binary number that specifies the analog input's position on a straight line lying between zero and full scale as defined for a given input by the zero span values in the database.

   b. Amplitude Limit Check: This control function shall perform dual level, high/low amplitude limit checking and shall identify a limit violation every time a measured or virtual variable goes out-of-limits and returns back into limits. The control function shall determine the time at which each limit excursion occurred. A deadband shall be provided on each limit and shall be expressed as a percentage of span or in engineering units. Low and high limiting default values will be set-up for each measured or calculated variables used in the process control loops.

   c. Engineering Unit Conversion: This control function shall convert scaled analog data to engineering units by means of the following equation:

      $$Y = (H - L)\,(D/DH) + L$$

      where:

      Y = Value in engineering units.
      H = High value of span, expressed in engineering units.
      L = Low value of span, expressed in engineering units.
      D = Digitized scaled input value in counts.
      DH = Full scale digitized value in counts.

   d. Manual Control: It shall be possible for Operator or Plant Engineer to interrupt any sequence, loop or automatic operation and operate the same manually through the Operator Workstation except in cases where manual control induces unnecessary risk to equipment, such as startup and shutdown sequences.

   e. Verification of Digital Outputs: This control function shall verify that the equipment has responded to the digital commands before proceeding to next step during automatic operation. If any

discrepancy is detected, an alarm will be annunciated.

E. Hardware: Contractor shall provide all the hardware, as shown, specified or required to implement the control strategies as described.

F. Configuration: All set points, tuning parameters and engineering scales etc. shall be documented for each control point and each control strategy on configuration sheets or similar documents. These documents shall be updated during Factory Testing and finally during start-up.

G. All control loops shall be PID control loops unless otherwise indicated. Operators shall have the ability to access the P, I, and D parameters and the PID frequency parameter for each control loop and adjust the parameters to tune the control loop. The PID loop parameters shall be accessible by Operators at the OIT of the PLC that is executing the control logic, as well as the SCADA HMI application.

H. Control Strategy Displays: Control strategy displays shall be submitted for review. Displays shall clearly show initial conditions, start, and progression of the control strategies. Each control strategy shall be displayed in a minimum number of displays for ease of monitoring by the Operator.

I. Plant Power Failure: Plant equipment controlled by the control system shall be programmed to automatically reset upon failure.

J. Restart: All equipment and motors shall be automatically restarted after power failure by the control system in an orderly fashion approved by the Engineer.

K. All relays, training parameters, scales, configuration values, mathematical constants, equations and set points given in the control strategies are adjustable over a wide range. The values given are initial and may change during Shop Drawing review and may have to be readjusted during start-up.

1.2 SUBMITTALS

A. The control strategies are written descriptions of the basic configuration and/or programming required to implement regulatory and sequential control of the unit processes as shown on the P&IDs. They do not in all cases describe the process characteristics fully. Finalizing and tuning of strategies, as required, by process characteristics shall be accomplished during start-up. Control strategies shall fully reside in the memory of the designated PLC. The process inputs/outputs referred to in the Control Strategies are shown on the P&IDs. Any additional I/O (Maximum 20 percent) required shall be added during Shop Drawing review. It shall be provided at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 SOFTWARE APPLICATIONS

A. Develop custom Process Control System (PCS) software applications for this project as specified in PART 3 herein. Use licensing supplied with development software.

B. Develop custom HMI (Human Machine Interface)/OIT (Operator Interface Terminal) software applications for this project as specified in PART 3 herein. Use licensing supplied with development software.

C. Modify the Owner's existing SCADA software application as necessary to achieve the intended operational sequences, functional requirements, and control features as designed and specified herein. Design-Builder's CSI shall use their own licensing and development software with version matching the Owner's software.

PART 3 EXECUTION

3.1 CONTROL PANEL ALARM NOTIFICATION

A. When an alarm is generated in the associated control panel and it has not been demoted, the horn shall sound, and the strobe light shall flash.

B. The horn can be silenced by pressing the Silence pushbutton on the panel. The strobe light only shall be reenergized if the alarm has been acknowledged on the OIT and the alarm has cleared.

3.2 AERATION CONTROL SYSTEM (BY BLOWER SUPPLIER, AS REQUIRED BY SECTION 11610)

A. System Overview

1. The Aeration Control System (ACS) shall monitor the dissolved oxygen (DO) in each of five (5) Aeration Tanks, control the blowers, air flow valves, and any other required equipment, to maintain the dissolved oxygen in each Aeration Tank to a specified setpoint.

2. The blower system consists of five (5) integrally geared centrifugal blowers (IGC) located within the Aeration Blower Facility, and includes the following components:

a. Motor and shaft

b. The inlet piping for each blower with an inlet filter/silencer and temperature element

c. Motor operated Inlet Guide Vanes (IGVs) and Variable Diffusers, which are used to modulate and control the blower air flow output

d. The discharge piping for each blower with a pressure instruments, temperature instruments, expansion cone and discharge check-valve.

e. The blow-off piping with a blow-off valve that allows air flow to be discharged to the atmosphere to prevent the blower from surging, as well as to facilitate the startup and shutdown of the blowers.

3. The blowers shall be provided with a packaged aeration control system supplied by the blower manufacturer.

   a. The Aeration Control System shall be a PLC-based control system.

   b. The Aeration Control System shall consist of an Aeration Control Panel (ACP) and a Local Control Panel (LCP) for each blower (BLW-LCP-1, 2, 3, 4, and 5). Each of these control panels shall be equipped with a PLC (PLC-BCP-1, 2, 3, 4, and 5), panel-mounted OIT and a network switch for interfacing to the existing SCADA network as required by the Contract Documents.

   c. The five (5) aeration blower LCP PLCs shall communicate with the Aeration Control Panel PLC (PLC-ABF) via Ethernet as shown on Contract drawings. PLC-ABF shall in turn interface to the existing plant SCADA via Ethernet as shown on the Contract Documents.

4. The five (5) blowers discharge air into a main aeration header. Each aeration tank receives air via two separate aeration tank headers that branch off the main aeration header. The first aeration tank header delivers air to pass A and pass B in each tank, and the second header delivers air to pass C and pass D in each tank.

5. Each aeration tank header aeration zone shall have:

   a. A venturi flow meter to measure flow through the header.

   b. A motor operated butterfly control valve that shall be modulated to control the air flow rate into each aeration tank header.

c. A manually operated butterfly valve that shall be used to isolate its associated header.

6. Each aeration tank shall be equipped with two (2) dissolved oxygen probes for monitoring the dissolved oxygen level within the Aeration Tank.

   a. The first DO probe measures the DO concentration in pass B of each aeration tank and thus measures the amount of air being delivered by the first aeration tank header.

   b. The second DO probe measures the DO concentration in pass D of each tank and thus measures the amount of air being delivered by the second aeration tank header.

7. Each aeration tank shall be equipped with ammonia and nitrate sensors for monitoring the level of ammonia and nitrate in pass D of each aeration tank.

8. The aeration control system shall be integrated into the existing plant SCADA system via an Ethernet connection as shown on the Contract Drawings. The plant SCADA system shall have the ability to monitor and control the aeration blowers from all plant SCADA OWSs.

B. Aeration Control Panel (ACP)

1. The ACP shall be a standalone PLC based control panel, and shall be networked to each of the five (5) aeration blower LCPs (BLW-LCP-1, 2, 3, 4, and 5).

2. The ACP shall be equipped with an OIT for monitoring and control of the Aeration Control System.

3. The ACP shall have the following capabilities to monitor and control the five (5) aeration blowers:

   a. Start/Stop each of the five (5) aeration blowers.
   b. Input Dissolved Oxygen (DO) Setpoint.
   c. Input Total Flow Setpoint Setpoint.
   d. Send flow setpoints to each of the Blower LCPs.
   e. Input Process Air Header Pressure Setpoint
      (1) Static Header Pressure
      (2) Dynamic Header Pressure

C. Dissolved Oxygen Monitoring

1. The ACP shall provide the Operators the ability to establish a dissolved oxygen setpoint (DOSP) for each aeration tank.

2. The ACP shall monitor the dissolved oxygen in each tank.

3. Dissolved oxygen error (DOE) shall be defined as the difference between the measured dissolved oxygen measurement and the dissolved oxygen setpoint.

D. Air Flow Control Loops

1. The ACP shall have the ability to control air flow to each aeration tank header by modulating the aeration tank header air inlet valve to meet a flow setpoint. The air flow control loops shall be used within the operating modes described herein.

2. The flow control loops shall be configured as a proportional-integral-derivative (PID) feedback control loops. The ACP shall send a command to the air flow control valves to open or close to eliminate the deviation between the flow setpoint and the actual flow measured by the flow meter to each tank.

3. The flow setpoint shall be provided with an adjustable deadband to eliminate any cycling around the flow setpoint and to avoid excessive valve actuator manipulation.

4. The Operator shall have the ability to adjust the flow setpoint deadband at the ACP OIT or any plant SCADA HMI workstation.

5. Aeration Tank air flow control valves shall have hardwired signals to the Aeration Control Panel. Aeration Tank flow control valves shall be controlled and monitored by the Aeration Control Panel.

E. Automatic Operating Modes: The ACP shall provide the Operator the ability to select automatic control of the aeration system based on the following automatic operating modes. When an automatic operating mode is selected, the operating mode shall be applied to all Aeration Tanks that the operator has not placed into Manual mode.

1. AUTO FLOW Mode

   a. In AUTO FLOW mode, the air flow to each aeration tank header shall be controlled based on a manually entered flow setpoint. Each aeration tank header shall have an individual setpoint. The Operator shall have the ability to enter the aeration tank header flow setpoint at the ACP OIT or at any SCADA OWS.

   b. In AUTO FLOW mode, the dissolved oxygen probes are used to assist the Operators in adjusting air flow to each tank. The Operators shall have the ability to enter a desired dissolved oxygen setpoint (DOSP) for each aeration tank header. Since there are two (2) DO probes in each of five (5) tanks, the aeration control system needs to accept ten (10) different DOSPs.

   c. The ACP shall generate an alarm when the dissolved oxygen measurement moves away from the target setpoint by a specific dissolved oxygen deadband (DODB) (specified in ppm). The alarm shall be annunciated at the ACP OIT and all SCADA OWS.

   d. Operators shall have the ability to adjust the dissolved oxygen deadband (specified in ppm) at the ACP OIT or any SCADA OWS.

   e. The alarm shall signal to the Operator to make an adjustment to the aeration tank header flow rate. Operators will adjust the flow to each aeration tank header by adjusting the aeration tank header flow setpoint. The Aeration Control System shall modulate the air flow control valves for aeration tank header to deliver the desired flow setpoint.

   f. Total Flow Demand Setpoint: The Aeration Control System shall add all the flow setpoints for all aeration tank headers to calculate a Total Flow Demand Setpoint for the aeration system. The Total Flow Demand Setpoint shall be used to control blower output as described subsequently in this specification.

2. AUTO DO Mode

   a. In AUTO DO Mode, the dissolved oxygen in each aeration tank shall be controlled using a cascading control loops based on a dissolved oxygen setpoint (DOSP).

   b. The ACP shall check the DO in each aeration tank and calculate a flow setpoint for that aeration tank header based on the error between the measured DO and the DOSP. The flow setpoint for each aeration tank

header shall be calculated based on a Proportional-Integral (PI) control loop between the DO and flow setpoint. The parameters of the PI loop shall be adjustable through the OIT at the Aeration Control Panel and through the plant SCADA HMI application.

c. Each DO setpoint shall have an associated adjustable deadband. If the DO error is within the deadband, no control actions shall be taken.

d. When the flow setpoint for an aeration tank header is updated, the ACP shall automatically modulate the position of the associated air flow control valve. The valve shall be moved to a position such that the resulting flow measured in the aeration tank header matches the flow setpoint to the tank. The position command of the flow control valve shall be determined using a PID control loop between the flow setpoint and the position of the air flow control valve.

e. Total Flow Demand Setpoint: The Aeration Control System shall add all the flow setpoints for all aeration tank headers to calculate a Total Flow Demand Setpoint for the aeration system. The Total Flow Demand Setpoint shall be used to control blower output as described subsequently in this specification.

f. Most Open Valve (MOV): The AUTO DO Mode shall implement an MOV control strategy to drive the Aeration Control System to operate at the lowest possible pressure for energy efficiency.

(1) The Aeration Control System shall identify the aeration tank header that needs the most air by identifying the largest error between the measured DO below the DO setpoint.

(2) The air flow control valve in this aeration tank header shall be automatically moved to the most open position by PLC-ABF.

(3) The ACP shall then total the air flow setpoints for each tank to determine the total flow demand for the aeration system.

F. Manual Operating Modes: PLC-ABF shall provide the Operator the ability to select manual control of the aeration system based on the following manual operating modes.

1. MANUAL AERATION Mode

a. The Operator shall have the ability to place the entire Aeration Control System in MANUAL AERATION Mode from the ACP OIT or from any SCADA OWS.

b. When the entire Aeration Control System is placed in MANUAL AERATION mode, the operator shall manually start and stop the blowers and specify the blower output for all running blowers. Each running blower shall have the same output command. These commands can be executed from either ACP OIT or any SCADA OWS. Blower startup and shutdown sequences, interlocks, trips, surge protection, and overload protection shall remain automatic from the individual blower LCPs.

c. In MANUAL AERATION Mode, the Operator shall have the ability to adjust the position of each tank air flow control valve manually from the ACP OIT or from any SCADA workstation.

2. MANUAL TANK Mode

a. The Operator shall have the ability to place any individual aeration tank header in MANUAL TANK mode from the ACP OIT or from any SCADA OWS.

b. If an individual tank header is placed in MANUAL TANK mode, it shall be removed from the AUTO FLOW or AUTO DO mode algorithm. The Operator shall have the ability to control the tank air flow control valve in manual mode.

G. Aeration Tank Flow Limits

1. ACP shall establish minimum and maximum air flow limits for each Aeration Tank. The minimum and maximum air flow limits will override any control action regardless of operating mode.

2. Adjustable flow setpoints shall not be permitted to be configured less than the minimum allowable air flow or greater than the maximum allowable air flow.

3. Minimum flows shall be established to ensure adequate Aeration Tank mixing.

4. Maximum flows shall be established to avoid exceeding the maximum capacity of the diffusers.

5. The ACP shall not allow any automatic mode of operation to adjust the flow rates to the Aeration Tank below the minimum allowable flow or above the maximum allowable flow rate.

6. Preset the following airflow minimum and maximum values in the ACP. Operators shall be able to adjust minimum and maximum allowable flow rates at ACP OIT or any SCADA OWS. The ability to adjust the minimum and maximum allowable flow shall require a password.

Aeration Tank	Minimum Allowable Flow Rate	Maximum Allowable Flow Rate
All Aeration Tanks, Pass A and Pass B	3,300 scfm	12,650 scfm
All Aeration Tanks, Pass C and Pass D	2,760 scfm	10,580 scfm

H. Blower Control: AUTOMATIC Mode

1. Operators shall be able set the blower control setpoints to either flow setpoint control mode or header pressure setpoint control mode.

2. AUTOMATIC Mode (Tank Header Flow Setpoint Control)

   a. Changes in the tank header flow setpoints will be made by the Aeration Control System to meet the DO demand in the Aeration Tanks. As tank header flow setpoints are changed, the ACP shall command the tank header air flow control valves to open or close to meet the flow setpoint demand.

   b. Total Flow Demand Setpoint (TFD): The Aeration Control Panel shall add all the flow setpoints for all aeration tank headers to calculate a Total Flow Demand Setpoint for the aeration system. The Total Flow Demand Setpoint shall be used to control blower output as described subsequently in this specification.

   c. The Aeration Control Panel (ACP) shall determine how many blowers need to be operating to meet the TFD.

      (1) The Aeration Control Panel shall either prompt the Operators to start a blower or start a blower automatically, if that option has

been selected by the operators, when the operating blowers are at 100% output and cannot meet the Total Flow Demand.

(2) The Aeration Control Panel shall prompt the Operators to stop a blower when the operating blowers at the minimum output flows and the total flow being delivered exceeds the Total Flow Demand.

(3) Operator prompts shall be displayed on the Aeration Control Panel OIT and shall also be displayed on the SCADA HMI workstations throughout the WWTP.

d. The ACP shall send capacity setpoints to the operating Blower LCPs. The Blower LCPs shall then control the blower output to meet the flow setpoint.

3. Blower Control: AUTOMATIC Mode (Main Header Pressure Setpoint Control)

(1) Changes in the tank flow setpoints will be made by the Aeration Control System to meet the DO demand in the Aeration Tanks. As flow setpoints are changed, the ACP shall command the tank air flow control valves to open or close to meet the flow setpoint demand. As these valves are opened and closed, the pressure in the common air discharge header will change.

(2) The pressure in the common air discharge header is measured by three pressure transmitters. Operators shall have the option to either use the average value of the three pressure transmitters or to select one of pressure transmitters as the measured value of the pressure of the discharge header.

(3) The Aeration Control System shall control the blowers to maintain a blower system pressure in the common air discharge header to a pressure setpoint. The pressure setpoint shall be known as the blower system pressure setpoint (BSP). Operators shall have the option to either use a static pressure setpoint or a dynamic pressure setpoint.

(a) For dynamic pressure setpoint control, the operators shall select an initial pressure setpoint which will be dynamically adjusted by the PCS based on the positions of the header valves.

(4) Operators shall have the ability to change the BSP at either the ACP OIT or from any SCADA workstation at the plant. The BSP shall be password protected. Operators shall be required to enter a

password prior to changing the BSP.

4. Blower Output Control

   a. Inlet Guide Vanes (IGVs): The blower inlet guide vanes shall be throttled open or closed to change the output of the running blowers. The IGVs shall be controlled by the associated Blower LCP.

   b. Diffuser Guide Vanes (DGVs): The diffuser guide vanes shall be throttled open or closed to operate the blower at the highest efficiency point. Diffuser guide vane position shall be controlled by the associated Blower LCP. The Blower LCP shall use differential pressure and differential temperature from the inlet to the discharge of the blower to determine the most efficient operating point and the position setpoint for the DGVs.

   c. The blowers shall be controlled by the Aeration Control System to operate in either cascade or parallel mode.

      (1) In cascade mode, if more than one blower is running, after sequentially ramping up, then the output of the last blower of the sequence shall be modulated to meet the TFD or BSP. All other operating blowers shall operate at 100% output.

         (a) Example: If there are two (2) blowers operating, the system will have a Lead and Lag1 blower operating. The Lead blower will operate at 100% output, and the output of the Lag1 blower will be modulated by the ACP to meet the TFD or BSP.

      (2) In parallel mode, if more than one blower is running, then the inlet valves of all operating blowers shall be controlled together such that all blowers are producing the same air flow.

         (a) Blower inlet valves shall be throttled to maintain the TFD or BSP.

5. Blower Lead / Lag Sequencing:

   a. Blowers shall be controlled in a Lead-Lag1-Lag2-Lag3-Lag4 sequence.

   b. When the number of operating blowers cannot meet the TFD or BSP, then the next available blower in the sequence will be started. For example, if the Lead blower is operating and cannot meet the TFD or BSP, the next blower to start would be the Lag1 blower. The next

would be the Lag2 blower and so on.

c. When the number of operating blowers is delivered air flow that exceeds the TFD or BSP, the first blower to be stopped would be the first blower in the sequence. For example, if there are three blowers operating (Lead-Lag1-Lag2), then the blower to be stopped would be the Lead blower. The new sequence would be such that Lag1 would become the new Lead blower and Lag2 would become Lag1.

d. If a blower fails, it shall be replaced by the next available blower in the sequence. The failed blower shall be removed from the sequence.

e. Blower sequence shall be manually selected (by authorized personnel) or automatically selected by PLC-ABF. In manual selection mode, the authorized personnel designated/identified each blower individually and uniquely as Lead, Lag1, Lag2, Lag3 or Lag4 from the ACP OIT or SCADA HMI workstations. PLC-ABF shall maintain these blower designations until manually changed by authorized personnel or the sequencing mode is changed to automatic. In automatic sequencing mode, PLC-ABF shall automatically change the blower designations at the interval (number of hours, days, weeks or months) selected by the authorized personnel. PLC-ABF shall automatically designate each pump in the order of least runtime to most runtime to even out blower runtimes.

6. Blower Sequencing – Increasing Blower System Output

a. To meet the demand of the aeration system, blowers may need to be started to provide additional airflow to the aeration system. Operators shall have the capability of determining whether when an additional blower needs to start, whether the ACP shall be able to automatically start a blower, or if the ACP shall prompt operators to start a blower.

b. Before starting an additional blower, all operating blowers must be operating at maximum output capacity with the inlet guide vanes at the position that produces the maximum blower flow.

c. If all blowers are operating at maximum output, and the TFD or BSP is not being met, then an additional blower will need to be started. To start an additional blower:

(1) First, ramp down the operating blowers to minimum blower output.
(2) Start the additional blower.
(3) If in parallel mode ramp up all operating blowers together to meet the TFD or BSP. All operating blowers shall be controlled

together such that the inlet throttling valves are positioned simultaneously to produce the same output for all blowers. If in cascade mode, after all operating blowers sequentially ramp up, the lead blowers in sequence shall operate at 100% while the blower which has just started shall be modulated by the ACP to meet the TFD or BSP.

d. Blower Startup Sequence

(1) Operator issues a blower start command from the ACP OIT or from a SCADA HMI workstation.

(2) Ramp down the operating blowers to a safe startup setpoint.

(3) Blowers shall be started with the associated blow-off valve in the open position and the associated discharge valve in the closed position.

(4) Start the lube oil system for the next blower in the operating sequence (Lag1, Lag 2, etc.)

(5) When the pre-lube sequence is complete, start the motor of the blower with the IGVs and DGVs positioned for minimum flow capacity.

(6) When the blower motor reaches its rated speed, open the discharge valve and start closing the blow-off valve.

(7) The blowers shall run in either cascade or parallel mode.

7. Blower Sequencing – Reducing Blower System Output

a. To meet the demand of the aeration system, blowers may need to be stopped to reduce the airflow to the aeration system.

b. Before stopping an operating blower, all operating blowers must be operating at minimum output capacity with the inlet guide vanes at the position that produces the minimum blower flow.

c. If all blowers are operating at minimum output, and the TFD or BSP is being exceeded, then an operating blower will need to be stopped. Blowers shall NOT be stopped automatically by the ACP. To stop a blower, the ACP shall display a prompt to the Operators that an operating blower needs to be stopped to reduce flow to meet the Total Flow Demand of the aeration system. This prompt shall be displayed

at the ACP OIT and at all the SCADA HMI Workstations at the WWTP.

d. Blower Shutdown Sequence

(1) Operator issues a blower stop command from the ACP OIT or from a SCADA HMI workstation.

(2) The ACP sends a stop command to the Blower LCP and the motor is stopped.

(3) Open the associated blow-off valve and close the associated discharge valve.

(4) When the blower has come to a complete stop and the shaft is no longer spinning, start the lube oil shutdown sequence.

I. Blower Control: REMOTE MANUAL Mode

1. Operators shall have the ability to place each blower into REMOTE MANUAL Mode at the ACP OIT. When placed in REMOTE MANUAL Mode at the ACP OIT, control from any SCADA OWS shall be disabled.

2. If a Blower is placed in REMOTE MANUAL Mode, the ACP shall not automatically adjust blower outputs to the Blower LCPs. In REMOTE MANUAL mode, Operators shall manually initiate startup, shutdown, and adjust blower output control using the ACP OIT.

3. In REMOTE MANUAL mode, the Aeration Control System shall still perform appropriate startup, shutdown and surge protection functions for each blower to protect the equipment and plant personnel.

4. Operators shall have the ability to place each blower into REMOTE MANUAL Mode from any SCADA OWS.

a. When placed in REMOTE MANUAL Mode from a SCADA OWS, the Operator shall have the ability to manually perform the blower control functions from SCADA as described in this specification.

b. Using REMOTE MANUAL mode from the ACP OIT shall override control from any SCADA OWS. Operators shall receive an indication on the SCADA OWS if a blower has been placed in REMOTE MANUAL mode at the ACP OIT.

J. Local Control Panel (BLW-LCP-1,2,3,4,5)

1. Individual LCPs for each blower shall be supplied as part of the packaged aeration control system. The LCP shall be equipped with OIT, indication lights and pushbuttons to perform monitoring and control of the associated blower.

2. LOCAL Mode: When the Local/Off/Remote switch is in LOCAL, the LCP shall provide following capabilities to control the associated aeration blower:

    a. Startup Individual Blower
    b. Shutdown Individual Blower
    c. Perform surge control and equipment protection.
    d. Blower Output

3. The following conditions and pushbuttons shall be displayed at LCP for each aeration blower

    a. Blower Running (red light)
    b. Blower Fault (amber light)
    c. Emergency Stop (pushbutton)
    d. Local/Off/Remote (selector switch)
    e. Start/Stop (pushbutton)

K. Blower Interlocks and Annunciators: Design the Aeration Control System to monitor the blowers as follows. Each individual local control panel shall control its associated blower and valves during surge and overload conditions.

1. Impending Surge interlock: When the Aeration Control System activates the Impending Surge bit, lock the operation of the air flow control valves at the tanks to prevent any further reduction in air flow until the Impending Surge condition has passed. Air flow setpoints can increase during this condition, but are not to be decreased as long as the Impending Surge interlock is active. When this interlock occurs, alarm the condition and alert the operators at the ACP OIT and SCADA HMI workstations. The following parameters shall be monitored for surge protection:

    a. Inlet/Discharge Pressure
    b. Inlet/Discharge Temperature
    c. Motor Current and RPM

2. Impending Overload interlock: When the Aeration Control System activates the Impending Overload bit, lock the operation of the air flow control valves at the tanks to prevent any further increase in air flow until the Impending Overload condition has passed. Air flow setpoints can

decrease during this condition, but are not to be increased as long as the Impending Overload interlock is active. When this interlock occurs, alarm the condition and alert the operator at the ACP OIT and at the SCADA HMI workstations. The following parameters shall be monitored for overload protection:

a. Inlet/Discharge Pressure
b. Inlet/Discharge Temperature
c. Motor Current and RPM

3. Blower Start/Stop interlock: When the Aeration Control System activates this interlock, it signifies that a blower start or stop sequence has been activated. At this point, configure the system to lock all tank air flow and DO control loops for an adjustable time delay (set initially at 15 minutes) to allow the blower controls and system pressure to stabilize. After the delay, return the controls to automatic.

4. The Aeration Control System shall provide surge protection and blower trips based on monitoring the following operating parameters for each blower:

a. Inlet Filter Differential Pressure
b. Inlet Temperature
c. Inlet Pressure
d. Inlet Guide Vane Position
e. Diffuser Vane Position
f. Blower Bearing Temperature
g. Blower Vibration
h. Discharge Temperature
i. Discharge Pressure
j. Blow-Off Valve Position
k. Motor Current/Overload
l. Motor Winding Temperature (1 RTD per phase)
m. Motor Bearing Vibration
n. Motor Bearing Temperature
o. Emergency Stop (Shutdown) Pushbutton

L. Power Failure

1. Design PLC discrete output commands for the blowers as individual momentary start and stop requests requiring blowers to be individually restarted after a power failure. Power failure is defined as breaker/blower tripped. Return from a power failure is defined as breaker/blower no longer tripped and closed.

2. One blower based on lead/lag sequencing will automatically restart after a

power failure from a command in the Aeration Control Panel. Additional blowers may be restarted manually by the operator at the ACP OIT or the SCADA Workstation.

3.3 AERATION CONTROL SYSTEM – SCADA INTEGRATION (BY AESS)

A. The AESS shall integrate the Aeration Control System into the existing plant SCADA network.

B. The aeration control system shall be integrated into the existing plant SCADA system via Ethernet interface to the ACP as shown on the Contract Documents.

1. AESS shall integrate all I/O points from PLC-ABF into the plant SCADA system. Operators shall have access to all operating parameters from any SCADA OWS.

2. AESS shall display all alarms that are generated by ACP in the plant SCADA system. Operators shall receive all alarms from ACP OIT and at all SCADA HMI workstations.

C. The plant SCADA system shall have the ability to monitor and control the aeration control system and the aeration blowers from all plant SCADA HMI Workstations.

D. AESS shall develop Aeration Control System SCADA screens as follows:

1. Aeration Control System Blowers Screen

a. Displays all blowers with operating status (running/off) and operating mode (AUTOMATIC, REMOTE MANUAL or LOCAL).

b. Displays all blowers with associated piping, discharge valve, and blow-off valve.

c. Displays the common suction header, individual inlet and discharge piping, and common discharge header.

d. Displays the position of the discharge valve and blow-off valves.

e. Displays the main blower system header pressure, and provides the ability to change the blower system header pressure setpoint. Modifications to the blower system header pressure setpoint shall be password protected.

(1) The main blower system header pressure is determined by

three pressure transmitters. Operators shall have the ability to either select a single transmitter for pressure control or to use the average of all three pressure transmitters. If using the average of three pressure transmitters, a deviation alarm among the transmitters is to be provided so that the transmitter out of spec does not skew the average reading.

f. Provides the ability to place individual blowers in REMOTE MANUAL Mode.

2. Individual Blower Screen (to view detailed operating parameters for each Blower)

   a. The Operator shall have the ability to select an individual blower from the System Blower Screen.

   b. The individual blower screen shall display the following for each blower:

      (1) Operating status of the blower
      (2) Position of discharge and blow-off valves
      (3) Readings from all blower instrumentation monitored by the ACP
      (4) Provides the ability to place an individual blower in REMOTE MANUAL Mode from any SCADA OWS
      (5) Provides Operators the ability to start, stop and control blower output from SCADA when the blower is in REMOTE MANUAL Mode.
      (6) Using REMOTE MANUAL mode from the ACP OIT shall override control from any SCADA OWS. Operators shall receive an indication on the SCADA OWS if a blower has been placed in REMOTE MANUAL mode at the ACP OIT.

3. Aeration Control System Tanks Screen

   a. Displays the blower system header pressure

   b. Displays all tanks with:
      (1) Tank dissolved oxygen level with the location of the DO sensors within the tank
      (2) Air flow to the tank
      (3) Position of the air flow control valve

   c. The Tanks SCADA screen shall display the system control mode, as well as allow Operators to place the aeration control system into any of the allowable control modes, which shall be any of the following:

(1) MANUAL AERATION Mode
(2) AUTO FLOW Mode
(3) AUTO DO Mode

d. The Tanks SCADA screen shall display the control mode for each individual tank, as well as allow Operators to place the individual tanks into any of the allowable control modes, which shall be any of the following:
(1) MANUAL TANK Mode
(2) AUTO Mode

E. SCADA screens shall mimic ACP/LCP screens as closely as possible.

3.4 EXISTING PLANT SCADA SYSTEM MODIFICATIONS

A. Duplicate PLC-ABF and PLC-HVAC-ABF OIT screens on the Plant SCADA. Utilize existing HMI screens to maintain consistency with existing screens at the Nassau County plants.

1. Aeration screens to be a modification of the existing Glen Cove screens utilizing the PLC-ABF I/O points (3.06 B) and the existing Bay Park Aeration screens (3.06 A) with the existing MCP-1/MCC-IO equipment shown on the Plant SCADA system.
2. Add all I/O and setpoint variable screens from MCP-1 Emerson Quickpanel+ OIT to the Plant SCADA.

B. Modify existing Plant SCADA screens to incorporate the Medium Voltage and Low Voltage monitoring matching the existing screens.

C. Modify the existing MCP-1 OIT screens to remove the removed I/O associated with the analytical tanks.

D. All existing screens shall be available for use and modification.

3.5 MODIFICATIONS TO MCP-1 AND MCC-IO IN EXISTING AERATION BUILDING

A. Remove tank analytical instruments from MCP-1 that are being replaced under this contract. Physical wiring to be removed from the field terminal blocks. All I/O references in the PLC and OIT to be marked as spares. Existing plant drawings to be updated noting all removed I/O as “spare” for future use.

B. Provide communications from the redundant existing Emerson RX3i PLC CPUs to the new PLC-ABF for relaying of the existing I/O, setpoints, alarms and other registers.

C. Provide the functionality to modify the existing setpoints available on the OIT on the Plant SCADA.

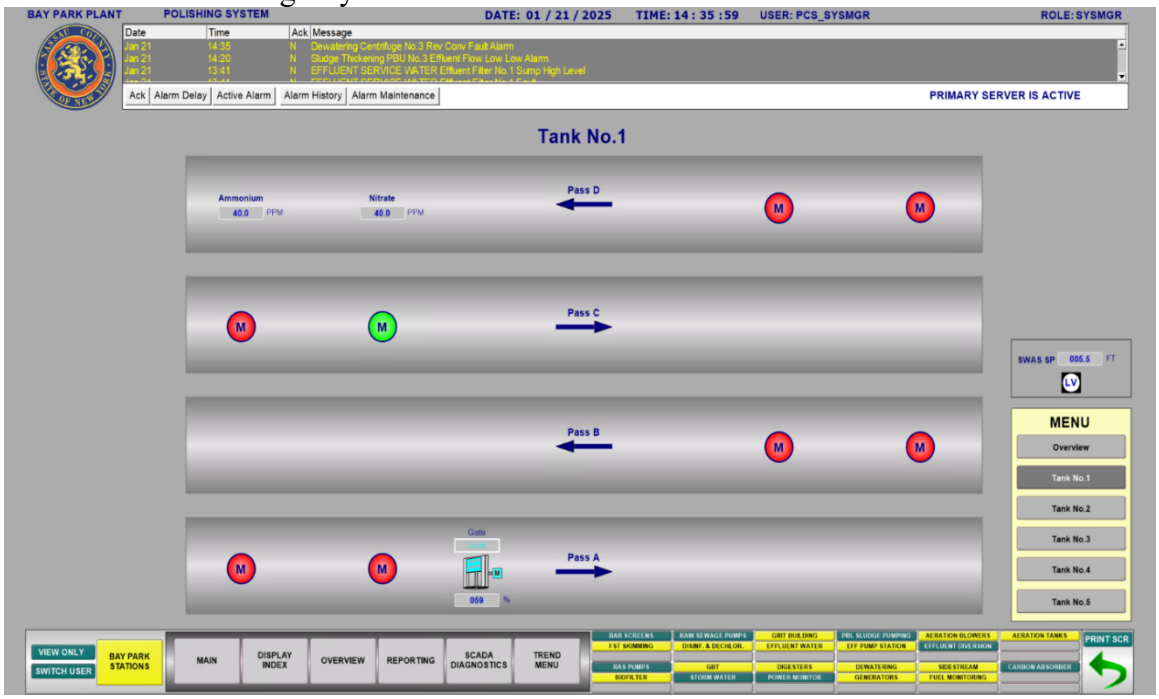
D. Move the redundant processors from MCP-1 and install within MCC-IO panel and re-wire for a functioning PLC system. Remove the I/O associated with MCP-1 from the PLC program.

E. Move the existing network switch from MCP-1 to MCC-IO and install to provide a functioning system and reconnect the connection from the network switch to FOCE-AER2.

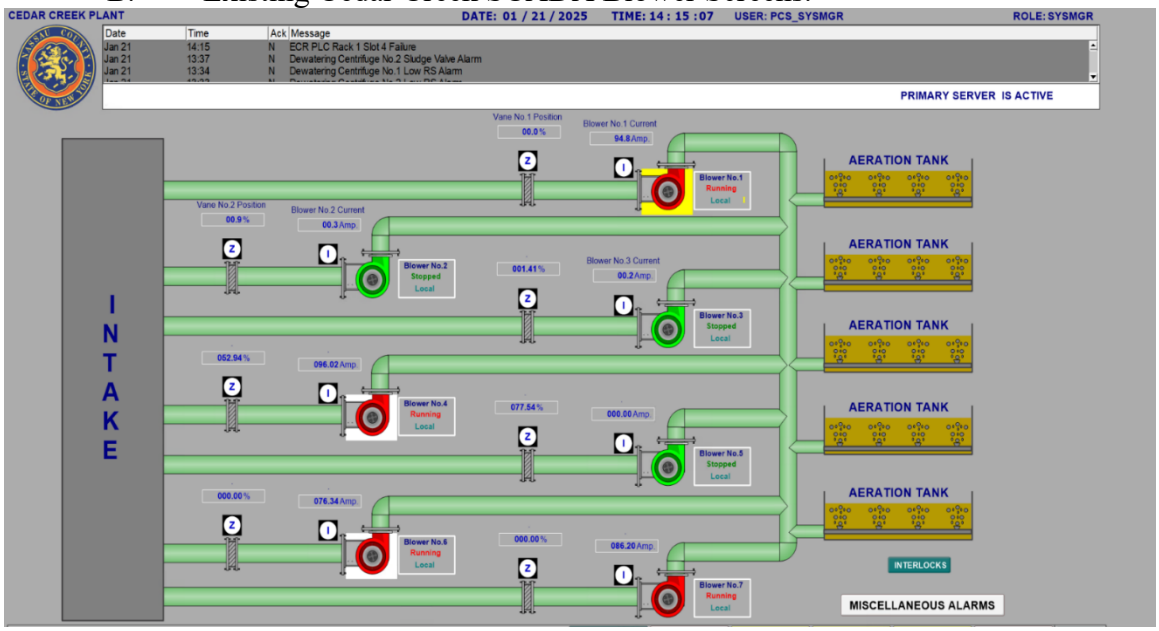
F. Verify functionality of MCC-IO without MCP-1. Remove MCP-1 and abandon in place.

3.6 EXISTING SCADA SCREENS

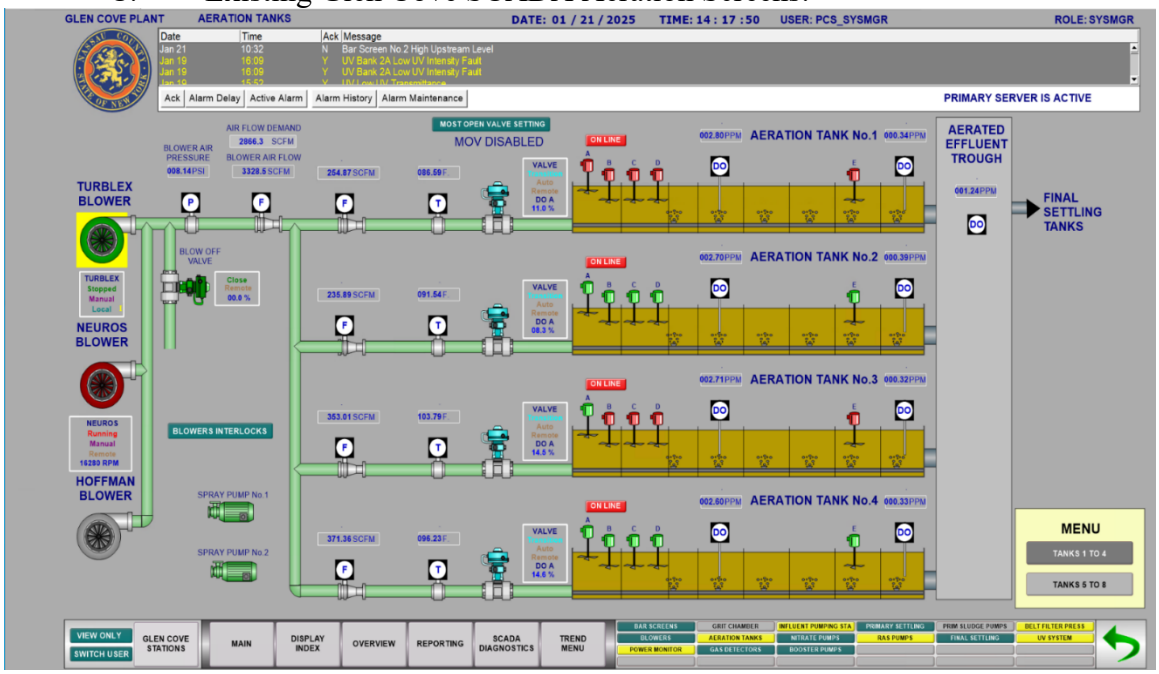
A. Existing Bay Park Plant Aeration SCADA Screen



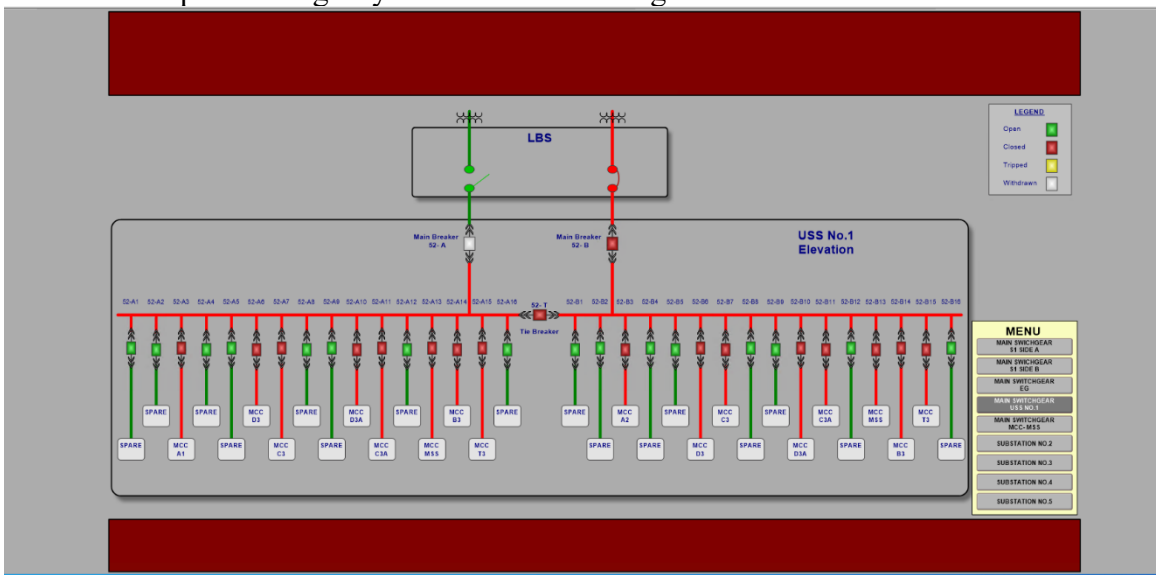
B. Existing Cedar Creek SCADA Blower Screens.



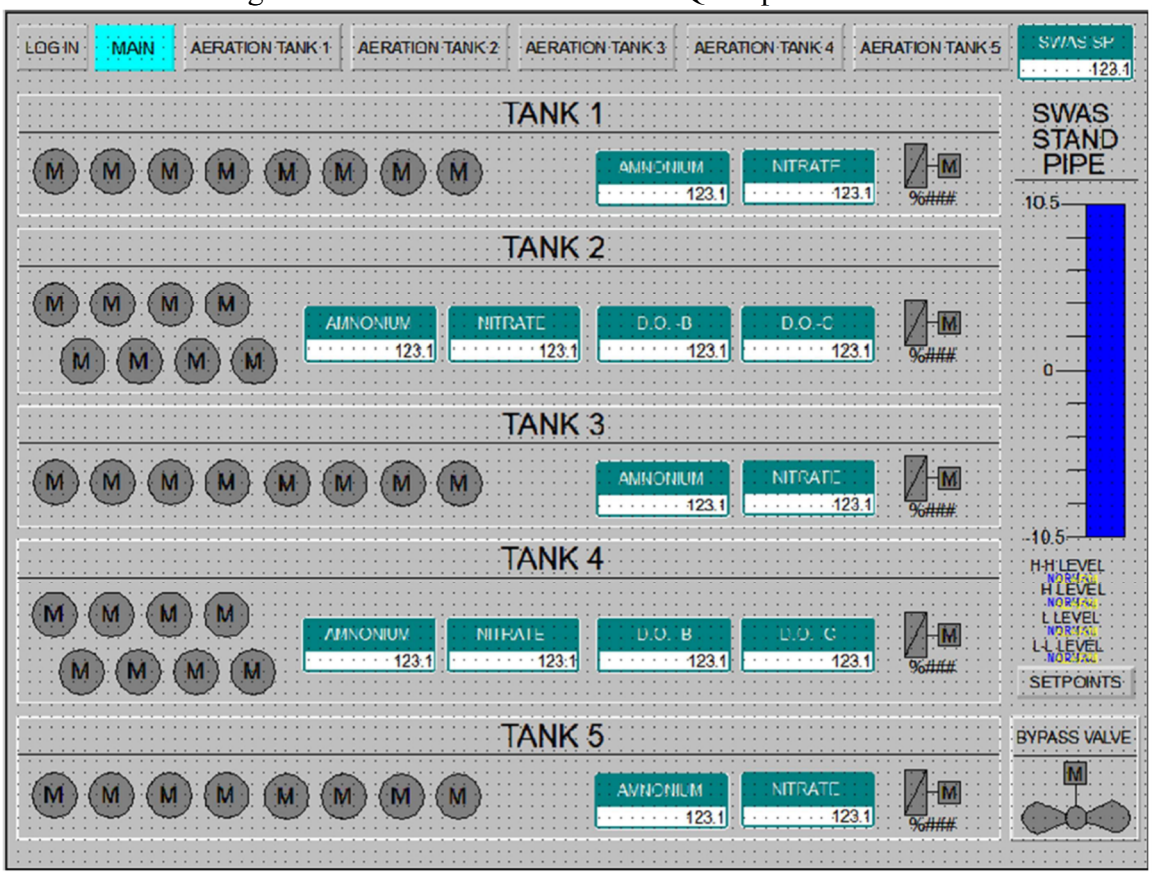
C. Existing Glen Cove SCADA Aeration Screens:

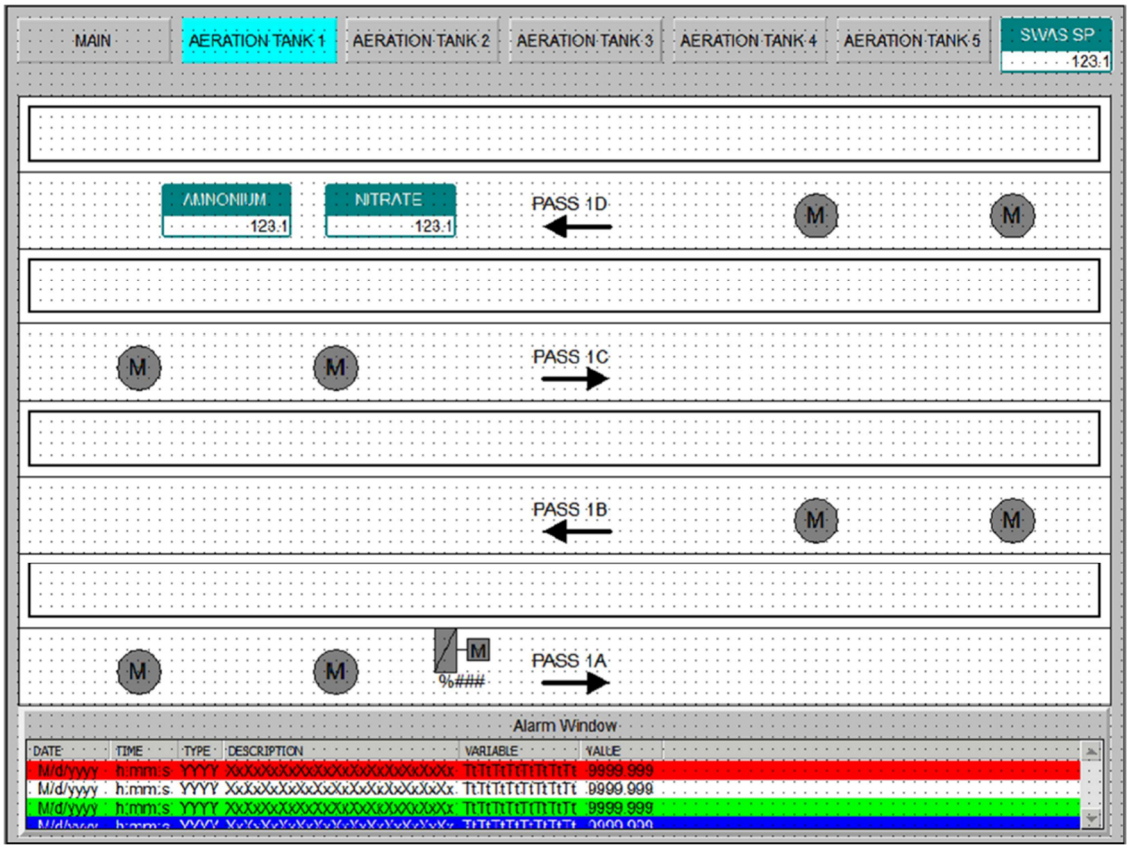


D. Sample existing Bay Park Medium Voltage SCADA Screen

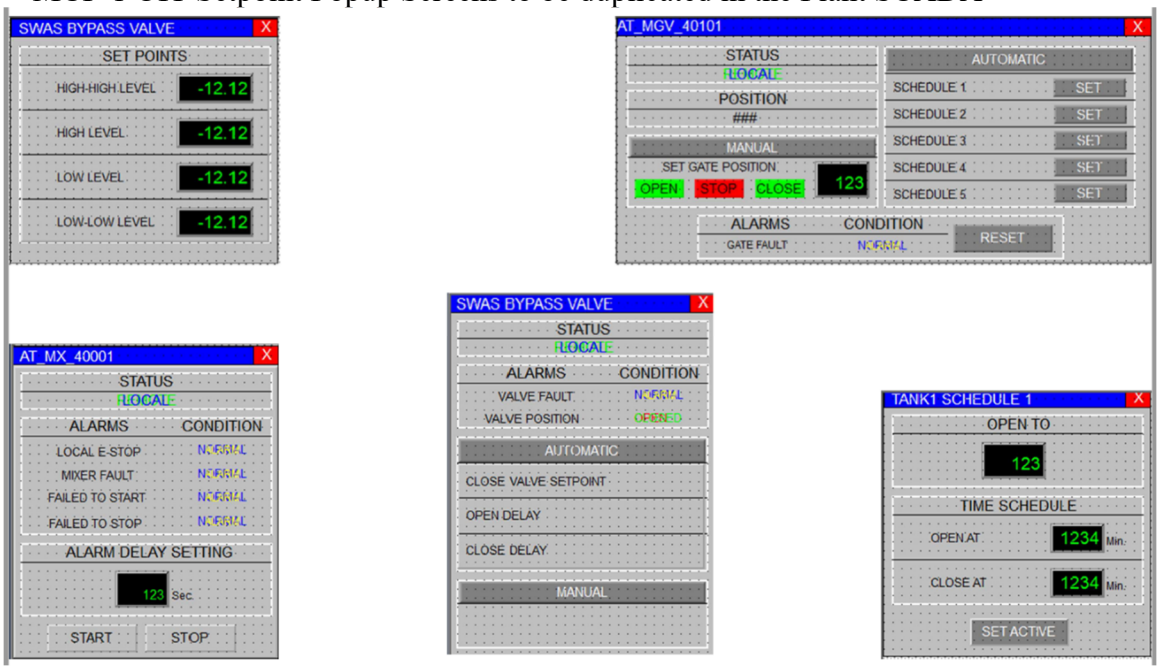


E. Existing MCP-1 OIT screens – Emerson Quickpanel+





F. MCP-1 OIT Setpoint Popup Screens to be duplicated in the Plant SCADA



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SECTION 13570

CONTROL CRITERIA

PART 1 GENERAL

1.01 DESCRIPTION

A. The Contractor shall load, configure, develop, test, document and place in satisfactory operation all software associated with the Process Control System (PCS) and all its ancillary devices, as described herein, required by other sections, indicated on the Contract Drawings and as necessary to provide a properly operating and integrated system.

B. In general, the software packages the Contractor will be required to furnish, install, customize, configure and develop shall include, but shall not be limited to:

1. PLC programing and Documentation Software.
2. PLC Network Communication Software.
3. OIT Programing Software.

C. Related Sections:

1. Section 13306, Applications Engineering Services
2. Section 13401, Process Control System General Provisions.
3. Section 13402, Process Control System Factory Testing.
4. Section 13403, Process Control System Start Up and Field Testing.
5. Section 13404, Process Control System Training.
6. Section 13480, Input/Output Point List.
7. Section 13491, Process Control Descriptions.
8. Division 16.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/ASQ Z1.4, Sampling Procedures and Tables For Inspection By Attributes.

2. ASTM A269, Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

3. ASTM A312, Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

4. ASTM A403, Specification for Wrought Austenitic Stainless Steel Piping Fittings.

5. IEEE 802.1X, Port Based Network Access Control.

6. IEEE 802.3, Standards Defining Physical Layer and Data Link Layer Media Access Control (MAC) Sublayer of Wired Ethernet

7. ISA 5.1, Instrumentation Symbols and Identification.

8. ISA 5.4, Instrument Loop Diagrams.

9. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

10. NFPA 70 (NEC), Article 770, Optical Fiber Cables and Raceways.

11. NFPA 79, Electrical Standard for Industrial Machinery.

12. UL 50, Safety Enclosures for Electrical Equipment, Non-Environmental Considerations.

13. UL 508A, Industrial Control Panels.

1.03 SUBMITTALS

A. The Contractor shall submit working drawings, shop drawings, and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions and Section 01300, Additional Submittals.

B. The Contractor shall submit the following information for approval prior to beginning actual work of developing software for the project:

1. Qualifications and certifications of system software engineers.

2. A listing of all proposed software packages indicating quantities and where they will be installed.

C. The Contractor shall provide the following items for review and approval by Engineer early in the project:

1. Preliminary logic code for all PLCs and general methods of implementing the various Process Control Descriptions.

2. Preliminary database and Process Control System Input-Output Listing showing system tag names and references.

3. Preliminary screen display count with general system structure.

4. Preliminary screen display development, general display organization and common components.

D. Contractor shall submit all completed items to Engineer for review and approval. As a minimum, the items to be submitted shall include, but shall not be limited to:

1. PLC logic code with full documentation and annotation.

2. Full Color copies of Graphic display screens.

3. Screen animation and control.

4. Databases.

5. Alarm and event log lists, formats and messages.

1.04 QUALITY ASSURANCE

A. Personnel

1. The I&C Supplier shall utilize system and software engineers who have been factory trained and certified on the respective software packages, to perform all programming functions, develop Process Control Descriptions, create graphic displays, customize applications, document all work and coordinate the software interface. They shall be intimately familiar with the details of this Contract, water treatment facility instrumentation and control in general and the project goals and requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL CONTROL PHILOSOPHY

A. In order for the Contractor to provide the most reliable and fault tolerant system of control and monitoring, a distributed approach to programming shall be implemented.

B. All control logic, loop control, critical alarming and I/O shall be done at the local (PLC) level.

C. OITs shall send only valid data to the PLC where it shall be "latched in" until such time as new valid data is made available. A failure of the OIT/workstation shall not prevent the PLC from continuing to function normally using the last valid data it received.

D. OITs, PLCs and network components, shall be monitored for failures by the redundancy of components through the use of "watchdog timers" programmed into the software. Failure of any component shall be alarmed and annunciated at the next level of control and the information shall be immediately made available on the network.

E. OITs shall monitor and display all digital and analog data available on their local PLCs and all pertinent data available on the network. Where possible, the software shall be configured to verify the validity of that data. Data that is in disagreement or out of valid range shall be indicated as such through the extensive use of displays and alarms.

3.02 PLC PROGRAMMING CONVENTIONS

A. General:

1. All logic, sequencing, interlocking, safety and critical alarm and control, shall be implemented at the PLC level using ladder type logic. Individual "rungs" shall be provided for each logic function. Subroutines shall be used where repetitive logic is required. Alarm logic shall not be performed in subroutines as they may not be active at all times.

2. Commands such as start, stop, open, close, operating mode, sequence selection, etc., that are sent from the workstation by operator initiative or response, shall be "pulsed" and "latched" into the PLC logic.

3. All analog loop control such as temperature, flow or level shall be performed at the PLC level, not in the workstation. All calculations and logic necessary to keep an individual loop in operation, in the event of failure of, or loss of communication with the workstation, shall also be done in the PLC.

4. Where possible, all data points, both analog and digital, associated with the PLC based loop controllers, shall be available to the operator at the

workstation and fully displayed and adjustable.

5. The PLC ladder program shall be so written that the operator, via a local or remote workstation/OIT, can select the mode in which he wants each individual loop to operate, i.e., manual/auto or local/remote set point. He shall also be able to view and manually adjust all parameters such as set point, output, gain, integral, derivative, etc., from the workstation. Once entered, the valid data shall remain stored in the PLC until such time as new valid data is received.

B. Program Structure:

1. All programming shall be implemented using ladder logic style programming only. Other styles of programming, where necessary, shall only be used with the prior written permission of the Engineer and only when the task cannot be performed using ladder type logic.

2. The program shall be written using a well-organized and well-documented structured approach. All common elements shall be grouped together as much as possible. For example, all logic for a single piece of equipment such as start stop logic, indication, fault and alarm logic shall be grouped together to allow easy startup and troubleshooting.

C. Safeties and Interlocks:

1. Upon initial startup or a subsequent restart of the PLC, the program shall be written to first initialize all logic and data; next, bring all equipment and controls to a safe and ready status as allowed by safety and interlock status and only then allow equipment to be started as indicated in the individual Process Control Descriptions. When the system has decided that all conditions are satisfied, it shall then issue a “ready” status for each piece of affected equipment, for display by the HMI.

2. Upon startup or restart of equipment and/or systems after a power failure, the program shall retain the status of all equipment prior to the interruption unless otherwise noted. Upon restoration of stable power, with a suitable and adjustable time delay on each piece of equipment, the program shall check the status of all controlled equipment and systems for faults and/or safety trips. Only then, allow equipment to be started as indicated in the individual Process Control Descriptions. Items indicating a faulted or unsafe condition shall be immediately locked out and the appropriate alarms generated for display by the HMI.

3. Where at all possible, all preset values (for timers, counters, etc.) and variables shall be stored in register memory and shall be made available to the operator at the HMI for both display and adjustment.

3.03 OPERATOR INTERFACE TERMINAL PROGRAMMING CONVENTIONS

A. General:

1. The operator interface to the System Software shall be through an organized system of graphic displays and tabular data displayed on the workstations and interface units throughout the system. In general, the graphic displays shall be based on a schematic representation of the process, as shown on the Contract P&ID diagrams and general equipment arrangement. While only one of each type of equipment may be depicted on the P&ID diagrams, all equipment, instrumentation, and devices shall be represented on graphic displays.

2. Displays of process equipment and piping shall be neatly laid out so as to be uncluttered and easily interpreted. Systems shall be displayed on multiple screens to allow all equipment and data to be shown clearly. When possible, displays of process piping and vessels shall be color coded to match the colors listed in the process piping schedules and shall match painting color schemes. This will allow the operators to easily identify, by color, what process is being viewed. If no color has been assigned to a certain process, the Contractor shall notify the Engineer who shall assign one.

3. Because of the complexity of the process control system and the advanced capabilities of the System Software, extensive use of animation, color and appearance change, and sound shall be employed.

4. Log-on and Password protection shall be required for all functions other than viewing general displays. Engineer shall decide the operator access level for each function provided by Contractor.

B. Display System Structure:

1. Displays shall be generally organized into groups based on the process with which they are associated. An area index screen shall be provided showing “links” which when picked, will access all other screens in that system. All changes and updates shall be made on a plant wide basis, updating all workstations in the plant with the latest screens and information.

2. All displays throughout the plant shall have certain common elements. These elements shall include but shall not be limited to the following.

   a. There shall be a group of quick access “buttons” located at the top of each screen. Each of these buttons shall be assigned to a system screen

and shall provide a link, which when picked, will display the assigned screen. When there are no alarms present on a given screen, the button shall be blank and disabled. When there is any unacknowledged alarm present on a screen, its assigned button shall flash the system's name in amber. These screen names shall be assigned by Engineer. When the alarm(s) has (have) been acknowledged but is (are) still present, the system's name shall show steady amber on the button. The relative position of these buttons shall not change from screen to screen within an area.

b. There shall be additional buttons provided at the bottom of each screen allowing access to frequently needed items.

(1) The first items shall be an ACKNOWLEDGE button. The ACKNOWLEDGE button shall only acknowledge alarms generated on that screen. All alarms and alarms not associated with a given screen, shall be acknowledged from the alarm history screen.

(2) The second item shall be an ALARM HISTORY button. This button shall immediately bring up the alarm history tabular display screen with the most recent alarms on the top of the list.

(3) The third common item shall be an INDEX button. This button shall immediately bring up on the display, the area index screen previously described.

(4) The remaining bottom buttons shall be used to provide direct links to other screens associated with the current screen. Some of these associated screens will be defined later. When possible, buttons for links to a particular screen shall occupy the same relative position from screen to screen.

C. Equipment Control Location Status

1. Each process and piece of process equipment (carbon adsorber, dampers, etc.) shall have field selector switches to transfer control of the equipment to the control panel level. The graphic representation for each unit shall have an adjacent text field indicating where the current control location is. The text background shall read "REMOTE" on a blue background when control is at the control panel and read "LOCAL" as appropriate on a yellow background when control is elsewhere.

D. Equipment Start/Stop Control:

1. All equipment started and stopped by the PLC(s) shall have an operator

graphic display on one or more of the graphic display screens. As indicated on the P&ID drawings, each piece of equipment shall have a specific method of starting. This can be manual ON/OFF control, manual START/STOP or a combination of HAND/OFF/AUTOMATIC. Starting, stopping or changing operating mode of any equipment or system shall require double action followed by a confirming dialog box.

2. The operator shall "click" on a predefined pick box within the desired equipment symbol causing a dialog box to appear. The dialog box shall contain buttons for the different mode selections available to the operator for that piece of equipment or system. An "OK" button shall also appear in the box which shall confirm the selection. Once completed, a second dialog box shall appear to reconfirm the selection with dialog such as "DO YOU WISH TO PLACE PUMP IN RUN MODE". The operator shall select a "YES" or "NO" button to confirm the selection. All dialog boxes shall have a "CANCEL" button which shall leave the system unchanged.

E. Alarms:

1. Provide six (6) levels of alarming for each analog variable: high-high, high, deviation low, deviation high, low, low-low.

2. Provide four (4) security levels:

   a. View Only (no changes allowed)

   b. Operator (limited changes allowed, i.e. set point, timer value)

   c. Supervisor (restricted changes as determined by the System Administrator or Plant Superintendent)

   d. Administrator (no restrictions)

3. Annunciate alarm with horn and strobe light provided in control panel and display appropriate alarm.

   a. The software shall display alarm status via color change or blink in line, text, or fill attributes.

   b. The software shall have both alarm summary and alarm history displays with configurable message text including: DATE, TIME, TAG NAME, ALARM EVENT, ALARM TYPE, VALUE, SETPOINT, SEVERITY.

   c. The alarm summary and alarm history displays shall be configurable for the color of alarm window, new alarms, ACK alarms, and RTN alarms.

d. Momentary alarms shall be reported by the software if the signal made a transition from the normal state to the alarm state and back to the normal state between the polling sequences of a remote unit.

e. Momentary normal states shall be reported by the software if the signal made a transition from the alarm state to the normal state and back to alarm state between the polling sequences of a remote unit.

f. Multiple alarm and multiple normal states shall be reported by the software if multiple transitions were made between polling sequences.

F. Trending:

1. Software shall allow the configuration of historical trend displays which update continuously as new values are acquired.

2. Historical trend display shall be in Variable versus Time format.

3. Historical trend display shall support scaling of both variable and time axes.

4. Historical trend display shall support 4 variables per graph.

5. Software shall allow any number of historical trend graphs per screen.

6. Software shall allow configuration of trend graphs and other animation (bar charts, pushbuttons, etc.) on the same screen.

7. The I&C Supplier shall develop and assign historical trends for all monitored system analog variables and shall submit proposed trend plot groupings as part of the system software documentation submittal.

++ END OF SECTION ++

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SECTION 14602

HOISTING EQUIPMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all professional services, labor, materials, tools, equipment, and incidentals as required to furnish, install, test and place into satisfactory operating condition hoisting equipment complete and operational. Included are:
      a. Six 10-ton monorail ultra-low headroom monorail hoisting systems with electrical motor operated trolley and motor operated wire rope hoist with pendant control and power distribution systems.

1.2 RELATED SECTIONS

A. Section 01605 – Control of Materials

1.3 REFERENCES

A. Codes and standards referred to in this Section are:
   1. ANSI B30.11
   2. ANSI B30.16
   3. ANSI B30.17
   4. ANSI B30.2
   5. ANSI/ASME HST – 1M
   6. ANSI/ASME HST – 4M
   7. CMAA Spec No 70
   8. CMAA Spec No 74
   9. NACM No.6001
   10. OSHA 1910.179

1.4 SYSTEM DESCRIPTION

A. Type and Capacity: Provide the following equipment:
   1. SixTen-ton ultra-low headroom monorail hoists with electrical motor operated trolley and motor operated wire rope hoist with pendant control.

B. Performance Requirements: Provide equipment meeting the performance requirements listed in Subsection 2.1.

1.5 QUALITY ASSURANCE

A. Qualifications: Provide hoisting equipment of complete assembled units of standard manufacture made by a company which has had equipment of equivalent capacity and design giving satisfactory service in similar installations, and which can furnish replacement parts which are completely interchangeable with the original hoist assembly.

B. Regulatory Requirements: Provide hoisting equipment meeting the requirements of the following specifications except as modified;

1. ANSI Safety Standards: B30.2, B30.11, B30.16, B30.17
2. Crane Manufacturers Association
    a. CMAA Specification No.70, for top running bridge and gantry type multiple girder electric overhead travelling cranes
    b. CMAA Specification No. 74, for top running and under running single girder electric overhead travelling cranes.
3. ANSI/HST Hoist Performance Standard Sheet ANSI/ASME HST-4M for electric wire rope hoists.
4. OSHA 1910.179, for Overhead and Gantry cranes.

1.6 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Product Data and Information: Submit catalog data and information for each unit.

C. Shop Drawings: Submit shop drawings, including arrangement and erection drawings of the equipment and control equipment, templates, schematic control diagrams, electrical connection diagrams, and complete description of the control system.

D. Quality Control: Submit the following quality control documents:
1. Manufacturer’s certified performance and material records
2. Manufacturer’s certified copies of Field Test Reports

E. Operation and Maintenance Manuals: Submit operation and maintenance manuals for each of the hoisting equipment.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1 and as follows:
1. Protect all electrical equipment from the weather during transit and storage by suitable means, including shrink wrapping or hand wrapping and taping.

1.8 SPARE PARTS

A. Furnish the following spare parts:
   1. One set of trolley truck bearing assemblies
   2. One year supply of lubricants

1.9 WARRANTY

A. Motorized trolleys, hoists, tracks, and all related equipment shall be warranted by the manufacturer for defects in materials and workmanship in accordance with the requirements of the Contract General Provisions.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for approval to the engineer.
   1. Electric Wire Rope Hoist system
      a. ACCO Materials Handling Systems, Inc.
      b. Shaw-Box hoist systems (owned by Columbus McKinnon)
      c. Robbins & Myers, Inc. Hoist and Crane Division (R&M Hoist)
      d. Or equal.

2.2 MATERIALS

A. General: Design monorail structures in accordance with AISC Standards. Design all load bearing parts with a safety factor of at least five at rated capacity loads, based on ultimate strength of the materials used. Arrange the equipment to operate within the space shown with adequate clearances, with minimum clearance to the nearest obstruction not less than 3 inches vertical and 2 inches horizontal.
   1. Arrange all working parts for convenient inspection, lubrication, adjustment, repair, or replacement. Assemble, paint, test, and adjust the equipment, in the shop as far as practicable before shipment.
   2. House the operating machinery and other exposed parts suitable, fabricate the exterior of the unit to have smooth surfaces of pleasing appearance.
   3. Design the hoist with an overload limit device to prevent damage to the equipment or structure if loads in excess of the specified capacity of the hoist are applied.
   4. Place an inscription, easily readable from the operating floor, on each jib crane unit showing the rated capacity of the equipment and control identification. Provide all appurtenances, caution markers, and appliances necessary to comply with applicable safety laws and codes.
   5. Provide trolley stops in hazardous areas with solid oak bumper blocks with recessed fasteners.

6. Unless otherwise specified, provide all hoisting equipment suitable for normal indoor or outdoor service or hazardous area service as shown, designed for the following service classification:
    a. Motorized hoist Class H-3 of Hoist Manufacturers Institute HMI-100.
7. Provide all hoisting equipment components designed for operation at a range of temperature 32 degrees F to +108 degrees F, and subject to extreme dust and corrosion conditions.

2.3 SYSTEM PERFORMANCE

A. System Description:
1. Lifting equipment shall conform to headroom, hook elevation, and side clearance requirements as shown. Document and provide required available lift height and capacity.
2. Lifting equipment and controls shall be rated NEMA 4X.

B. Special Service Conditions:
1. Lifting equipment in areas classified as hazardous shall be suitable for operation in Class 1, Division I, Group D environment as defined in NFPA 820.
2. Exposed mechanical equipment suitable for operation in Class 1, Division I, Group D environments shall be non-sparking.

C. Performance Criteria:
1. Monorail system for the Bay Park Aeration Blower Room
    a. Equipment Description: Ultra low headroom monorail system with electrically operated trolley and hoist, pendant control.
    b. Quantity: Six.
    c. Hoist Type: Electrically operated wire rope.
    d. Trolley Type: Electrically operated.
    e. Area Classification: Unclassified.
    f. Rated Capacity: 10 tons
    g. Required Lift: 13 feet
    h. Maximum Lifting Height: 13.5 ft
    i. Minimum Rated Hook Elevation: 25.25
    j. Power Distribution: Cable reels for HST 1 to HST 5. Festoon system for HST-7.
    k. Operating Temperature Range: -10 to 100 degrees F., indoor.

D. Underhung Trolley Wire Rope Hoist
1. Trolley Frames: Provide trolley frames for the underhung ultra-low headroom monorail hoists of welded rolled steel or cast steel construction or a combination of both.
2. Design trolley wheels to operate on the bottom flange of the monorail and of rolled, forged or cast steel with tapered, hardened treads, designed to carry the maximum wheel load under normal conditions without undue wear, with diameter no less than is

shown in Table 4.1 of Hoist Manufacturers Institute – Standard Specifications HMI-100-74 for contour wheels with treads no less than 1-inch wid e. Machine the wheels to match diameters with treads to match the rolling surface of the lower flange of the bridge girder or monorail beam.

3. Hoisting Drum: Fabricate the hoisting drum of high-grade cast iron or steel to withstand the maximum bending and crushing loads. Design the drum so that not less than two complete wraps of hoisting rope remains in the grooves when the hook is in the lowest position and there is no overlapping when the hook is in the highest position. Turn drum grooves from solid metal, grooved right- and left-hand for double reeving and provide grooves not less than one half the nominal wire rope diameter in depth. Provide the pitch diameter of the drum and running sheave not less than 24 times the nominal rope diameter. Equip the drum with shrouded flanges or the equivalent to prevent cable override. Install an adjustable geared limit switch at the upper and lower limits of the hook travel and an overload cutoff to prevent application of forces greater than the specified capacity of the hoist.
4. Drive: Provide a trolley of the electric motor-operated type with electric motor-operated wire rope hoist.
    a. Hoisting Wire Rope: Design hoisting rope specially for crane service, consisting of 6 x 37 type preformed improved plow steel strands over a fiber core.
    b. Wire Size: Size the hoisting wire rope in accordance with OSHA requirements and the Crane Manufacturers recommendation, and provide the rated load plus block weight divided by the number of parts of rope not to exceed 20 percent of the nominal breaking strength of the rope.
5. Bearings: Provide all bearings of the ball or roller type, conforming to the standards of the Anti-friction Bearing Manufacturers Association. Provide bearing housings that are split or designed to permit easy removal of the shafts. Prelubricate and seal all bearings for life.
    a. Design all bearings in the crane wheels, drive shaft bearings and gear reduction shaft bearings for a minimum B-10 bearing life of 5,000 hours.
6. Hoisting Blocks: Provide hoisting blocks of enclosed steel construction with forged steel hooks with spring-operated safety latches, supported on ball or roller bearings. Design hooks to rotate freely 360 degrees on the bearing support.
7. Gears: Design all gearing to meet the requirements of Section 4.2 of CMMA Specification No. 74 and AGMA Standards, and of helical or of spur type constructed of heat treated steel. Provide worm gears of bronze and with precision machined cut teeth. Provide all pinions of heat treated alloy steel. Enclose or guard gearing and provide either oil bath or splash lubrication.
    a. Design the gear reducer or gear motor specifically for crane service with minimum classification of Moderate Shock service and with minimum service factor of 1.0.
8. Brakes: Provide each electrically-operated hoist with a mechanical brake as specified above, and in addition, a dc magnetic brake, spring set and magnetically released or solenoid-operated shoe type motor brake acting directly on the motor pinion shaft the instant power is shut off, equally effective in both directions. Provide brakes which are

adequate to sustain the capacity load, capable of at least fifteen operations per minute, and permit smooth operation for inching.

E. Electric Motors
   1. Provide motors meeting the requirements of Section 26 05 60 - Electrical Requirements for Shop-Assembled Equipment except as modified below.
      a. Design hoisting equipment drive motors specifically for hoist service, conforming to NEMA STANDARDS Part 18 - Subsection "Integral-horsepower AC Crane Motors". Provide horizontal shaft, totally enclosed nonventilated, Class B insulated, 30 minute duty rated, high torque, high slip, induction motors, 1800 rpm maximum speed, suitable for operation at 480 volts, 3-phase, 60-hertz. Provide motors with lifetime lubricated ball bearings. Design motor and gear assembly for the crane application and provide Type D motors flange mounted to the gear reducer or integral motor and gear reducer. Provide motors whose maximum noise level measured 5 feet from each motor does not exceed 90 dBa.

F. Operation and Controls
   1. General: Provide operation and control equipment meeting the requirements of Section 26 05 60 - Electrical Requirements for Shop-Assembled Equipment.
   2. Starters: Provide each trolley and hoist motor with integral reversing starters, complete with automatic reset overload relays in NEMA 7 explosion-proof enclosure in hazardous areas. Arrange all components for positive starting in each direction.
   3. Standards: Provide all components complying with the NEMA Standards for Industrial Control for Cranes and Hoists, NEC, ASME B30.11 and ASME B30.16.
   4. Limit Switches: Provide hoisting controls which include an adjustable limit switch to limit the normal up and down travel of the hook with a second factory set fixed switch operated by the hook or block to stop the hoist when the highest safe point is reached. Furnish adjustable limit switches of the heavy duty control circuit or power circuit type. Connect limit switches to open the motor circuit and apply the brake, but not to prevent lowering by operation of the appropriate push button. Provide switches in enclosures of the same NEMA rating as the associated motor starter, and designed and installed so that they will not be damaged by swinging of the hook.
   5. Pendant Push Button Control Station: Support pendant push button control stations by a Type 316 stainless steel cable or chain paralleling the control cable sized to withstand any effort to pull the hoist with the cable. Provide control transformers for operating the pendant controller at (24) (115) volts ac. Provide each control cable of NEC Type SO and to include the required number of flexible No. 14 AWG copper conductors, all cabled with necessary fillers and tape, and a tough polyvinyl chloride sheath of at least 45 mils thickness. Provide one piece cables, without flaws, and supported by a Kellems type safety grip.
      a. Locate the pendant push button controller approximately three feet six inches above the operating floor similar to No. 2 of Figure 4 of Recommended Arrangement of Controllers, ASME B30.2.0 Section 2-1.10.3 Controller (k), except where otherwise specified. Provide an indicating light to show that

power is available. Furnish two push buttons for each motor, one for each direction of travel. For two speed trolleys or hoists, provide controlling push buttons of two position type for slow and fast speeds. Provide all push buttons of the momentary contact maintained pressure type, automatically de-energizing when the contact pressure is relieved. Enclose pendant controllers in the same type of NEMA enclosures as specified for the associated motor starters. Manufacture the pendant controller push button station of weatherproof nitrile-vinyl rubber or light-weight resilient molded Lexan for nonexplosion-proof enclosures and cast aluminum for explosion-proof enclosures.

G. Power Supply
   1. General: Provide all electric power supply equipment suitable for 480-volt, 3-phase, 60-hertz electric service. Provide all hoisting equipment with suitable junction boxes for connection of field services complete with a ground pad. Locate connections as shown.
   2. Festooned Type: Provide power supply of the festooned type consisting of 4-conductor heavy duty cable of adequate length to reach any point of trolley travel. Provide conductors of extra flexible stranded copper and of NEC Type SO supported at connections with a Kellems type safety grip. Provide the festoon system of suspended track type with sufficient intermediate carriers to support the cable with the loop depth not to exceed 36 inches. Rate the system for 10 amperes and include the safety supported and safety grip connectors to the drive and hoisting units and to the pendant controllers. Provide power connections in junction boxes.

H. Reel Type: Provide power supply of the reel type consisting of 4-conductor heavy duty cable of adequate length to reach any point of trolley travel. Provide conductors of extra flexible stranded copper and of NEC Type SO supported at connections with a Kellems type safety grip. Provide heavy duty corrosion resistant spring loaded pay out and auto retracting reels.

2.4 FINISHING

A. Surface Preparation and Painting:
   1. Surface preparation and shop painting is required for ferrous metals, equipment, and accessories. Do not paint stainless steel, aluminum, and machined surfaces.
   2. Clean and apply in the shop prime coat in accordance with Section 09900, Painting, unless otherwise specified.
   3. Apply in the shop finish coat in accordance with Section 09900, Painting, unless otherwise specified.

B. Gears, bearing surfaces, and other machined surfaces shall receive a heavy application of rust-inhibiting coating that shall be maintained during storage and until equipment is placed into operation.

2.5 IDENTIFICATION

A. Identify component subassemblies with stainless steel nameplates and each labeled with the following:
   1. Manufacturer and model number.
   2. Date of manufacture with pertinent ratings, operation, and maintenance information.
   3. Certification, stamp, or approval to applicable Laws and Regulations.

PART 3 – EXECUTION

3.1 INSPECTION

A. Not Used.

3.2 INSTALLATION

A. Monorail tracks shall be installed level, straight, joined and spaced to crane span within tolerances as specified in CMAA 70.

B. Install monorail hoisting equipment in complete accordance with the manufacturer's printed instructions and the approved shop drawings.

C. Install stops at limits of travel for each hoist system.

D. Provide required lubricants for initial operation.

3.3 FIELD QUALITY CONTROL

A. The installer shall be a CMAA member and shall check and approve all installations before operation as well as conduct field testing, in accordance with the requirements of the Contract Documents. In addition:
   1. Contractor shall verify that all work furnished and installed conforms to the requirements of the Contract Documents.
   2. Reports: Submit a report on completed installation to include the following: Reports shall provide complete information on materials used, tasks performed, persons contacted, problems corrected, test results, training, instruction, and any other pertinent information.

B. Preliminary Field Test:
   1. After the Contractor and the Engineer have mutually agreed that the equipment installation is complete and ready for preliminary operation use, the Contractor and a qualified representative or representative of the manufacturer shall conduct a running test of each hoist and its controls in the presence of Engineer to demonstrate that each hoist unit and its controls will function correctly.

2. Field test shall be run together with its controls. Tests shall demonstrate that each part individually and all parts together function correctly.
3. Prior to applying electrical power to an operating device, drive motor or motors used by an external source to demonstrate free operation of all mechanical parts.

C. Final Field Test:
1. After successful completion of the preliminary field tests, perform load tests in accordance with CMAA standards and the local Building Code requirements.
2. Contractor shall provide all necessary instruments, labor, tools, and materials to conduct the field testing.

D. In the event that the Contractor is unable to demonstrate that the equipment meets the requirements of the above described testing, the deficient equipment will be rejected, and the Contractor shall adjust and/or modify and retest the equipment as often as necessary to meet the specified requirements at no cost to the Owner.

3.4 MANUFACTURER'S SERVICES

A. At a minimum, the services of the manufacturer's representative shall be provided as indicated below. The number of visits and person-days per visit, indicated below, shall be understood as referring to total required services for the lot of equipment provided under this Section.

Visit	Purpose	No. of Visits	Person-days per Visit
1	Installation Checkout	2	2
2	Field Testing	1	2

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SECTION 15000

GENERAL MECHANICAL REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This section describes the general requirements for all mechanical (HVAC) items and (HVAC) systems required by the Contract Documents.

B. Comply with all Contract Requirements, General Conditions, and Division 01 Sections applying to or affecting the Work of Division 15.

C. Unless specifically dimensioned, the Work shown on the Drawings is in diagrammatic form only to show general arrangement.

D. Include, in the Work, all accessories and appurtenances, necessary and integral, for the intended operation of any system, component or device, as such systems, components and devices are specified.

E. Do not install pipe or conduit through ductwork.

F. If the pipe or duct size shown on the Drawings does not match the connection size of the equipment that it is connected to, provide the necessary transition pieces at the piece of equipment.

G. Do not use or allow to be used asbestos or asbestos-containing materials on this project. Be rigorous in assuring that all materials, equipment, systems and components thereof do not contain asbestos. Any deviations from this requirement shall be remedied at the Contractor's expense without regard to prior submittal approvals.

1.02 RELATED DOCUMENTS

A. The General Conditions and General Requirements Division 01 apply to the Work of this Section.

1.03 REFERENCE STANDARDS

A. Compliance with the following codes and standards shall be required:
   1. Codes, Rules and Regulations of the State of New York
   2. AABC American Air Balance Council
   3. ADC Air Diffusion Council
   4. AGA American Gas Association
   5. AMCA Air Moving and Conditioning Association
   6. ANSI American National Standards Institute
   7. ARI American Refrigeration Institute
   8. ASA Acoustical Society of America

9.	ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
10.	ASME	American Society of Mechanical Engineers
11.	ASSE	American Society of Sanitary Engineers
12.	ASTM	American Society for Testing Materials
13.	AWS	American Welding Society
14.	AWWA	American Water Works Association
15.	BSA	Board of Standards and Appeals
16.	FM	Factory Mutual
17.	F.S. or FED	Spec. Federal Specification
18.	IRI	Industrial Risk Insurers
19.	MEA	Materials and Equipment Acceptance
20.	MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
21.	NACE	National Association of Corrosion Engineers
22.	NEBB	National Environmental Balancing Bureau
23.	NEC	National Electrical Code (NFPA 70) / 2020
24.	NEMA	National Electrical Manufacturers Association
25.	NFPA	National Fire Protection Association
26.	OSHA	Occupational Safety and Health Act
27.	SMACNA Association	Sheet Metal and Air Conditioning Contractor's National
28.	TEMA	Tubular Exchanger Manufacturers Association
29.	UL	Underwriters Laboratories, Inc.
30.	USAS	USA Standards Institute (Formerly ASA)

B. Compliance with the following Codes, Rules and Regulations and those referenced within as applicable to work in the State of New York shall be required:
   1. New York State Industrial Code Rules
   2. New York State Building Code 2020
   3. New York State Fire Code 2020
   4. New York State Existing Building Code 2020
   5. New York State Fuel Gas Code 2020
   6. New York State Plumbing Code 2020
   7. New York State Energy Conservation Code 2020
   8. New York State Mechanical Code 2020
   9. International Property Maintenance Code 2018
   10. Uniform Fire Prevention and Building Code 2020
   11. ASHRAE 90.1 - 2019 (Commercial & all other Residential except Low-Rise Residential)
   12. NYStretch Energy Code 2020
   13. DEC New York State Department of Environmental Conservation - 6 NYCRR Part 613 Handling and Storage of Petroleum

1.04 DEFINITIONS

A. "Provide" means furnish and install, complete the specified material, equipment or other items and perform all required labor to make a finished installation.

B. "Furnish and install" has the same meaning as given above for "Provide."

C. Refer to General Conditions for other definitions.

1.05 ABBREVIATIONS

A. Reference by abbreviation may be made in the Specifications and the Drawings in accordance with the following list:

1. HVAC Heating, Ventilating and Air Conditioning
2. CM Construction Manager
3. AC Air Conditioning
4. H & V Heating and Ventilating
5. AWG American Wire Gauge
6. BWG Birmingham Wire Gauge
7. USS United States Standard
8. B & S Brown & Sharpe
9. OS & Y Outside Screw and Yoke
10. IBBM Iron Body Brass Mounted
11. WSP Working Steam Pressure
12. PSIG Pounds per Square Inch Gauge
13. PRV Pressure Reducing Valve
14. GPM Gallons per Minute
15. MBH Thousand BTU per hour
16. BTU British Thermal Units
17. WG Water Gage
18. LB Pound (Also shown as: #)
19. ASME American Society of Mechanical Engineers
20. ASTM American Society for Testing Materials
21. ABMA American Boiler Manufacturers Association
22. ASA American Standards Associates
23. MER Mechanical Equipment Room

See Drawings for additional abbreviations

1.06 REVIEW OF CONTRACT DOCUMENTS AND SITE

A. Give written notice with the submission of bid to the Engineer of any materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of Authorities having jurisdiction, and any necessary items of work omitted. In the absence of such written notice it is mutually agreed that the Contractor has included the cost of all required items in the Contractor's proposal for a complete project.

B. Contractors shall acknowledge that they have examined the Plans, Specifications and Site, and that from their own investigations they have satisfied themselves as to the nature and location of the Work; the general and local conditions, particularly those bearing upon transportation, disposal, handling and storage of materials; availability of labor, utilities, roads and uncertainties of weather; the composition and condition of the ground; the characters quality and quantity of subsurface materials to be encountered; the character of equipment and facilities needed preliminary to and during the execution of the Work; all federal, state, county, township and municipal laws, ordinances and regulations particularly those relating to employment of labor, rates of wages, and construction methods; and all other matters which can in any way affect the Work or the cost thereof under this Contract. Any failure by the Contractor to acquaint themselves with the available information concerning these conditions will not relieve them from the responsibility for successfully performing the Work.

C. Owner assumes no responsibility for any understanding or representation made during or prior to the negotiation and execution of this Contract unless such understanding or representations are expressly stated in the Contract and the Contract expressly provides that the responsibility, therefore, is assumed by the Owner.

1.07 MEASUREMENTS

A. Base all measurements, both horizontal and vertical from established bench marks. Make all Work agree with these established lines and levels. Verify all measurements at site; and check the correctness of same as related to the Work.

1.08 LABOR AND MATERIALS

A. Provide all materials and apparatus required for the Work of new and first-class quality. Furnish, deliver, arrange, erect, connect and finish all materials and equipment in every detail, so selected and arranged as to fit properly into the building spaces.

B. Remove all materials delivered, or work erected, which does not comply with Drawings or Specifications, and replace with proper materials, or correct such work as directed, at no additional cost to the Owner.

1.09 COVERING OF WORK

A. Do not cover up or hide from view any duct, piping, fitting, or other work of any kind before it has been examined or approved by the Engineer and/or other authority having jurisdiction over the same. Remove and correct immediately any unacceptable or imperfect work or unauthorized or disapproved materials discovered immediately after being disapproved.

1.10 PROTECTION

A. Protect the Work and material of all trades from damage and replace all damaged material with new.

B. Protect work and equipment until the Work is finally inspected, tested, and accepted; protect the Work against theft, injury or damage; and carefully store material and equipment received on site which is not immediately installed; close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.

C. Preserve all public and private property, along and adjacent to the Work, and use every precaution necessary to prevent damage or injury thereto. Use suitable precautions to prevent damage to pipes, conduits and other underground structures or utilities, and carefully protect from disturbance or damage all property marks until an authorized agent has witnessed or otherwise referenced their location, and do not remove them until directed.

1.11 CUTTING AND PATCHING

A. Provide all cutting and rough patching required for the Work. Perform all finish patching.

B. Furnish and locate all sleeves and inserts required before the floors and walls are built, pay the cost of cutting and patching required for pipes where sleeves and inserts were not installed in time, or where incorrectly located. Provide all drilling required for the installation of hangers.

C. Punch or drill all holes cut through concrete slabs or arches from the underside. Do not cut structural members without the approval of the Architect/Engineer. Perform all cutting in a manner directed by the Architect/Engineer.

D. Do not do any cutting that may impair strength of building construction. Do no drill any holes, except for small screws, in beams or other structural members without obtaining prior approval. All Work shall be done in a neat manner by mechanics skilled in their trades and as approved.

1.12 SUBMITTALS

A. Submit for review, shop drawings for all materials and equipment furnished and installed under this Contract. Submissions shall include but not be limited to:
   1. Ductwork layout drawings, air devices and accessories
   2. Piping and equipment layout drawings.
   3. Piping materials, valves, hangers, supports and accessories
   4. Automatic temperature control equipment, diagrams and control sequences
   5. Equipment, fixtures, and appurtenances
   6. Insulation
   7. Rigging Plan - Include the name of the rigging company; a layout drawing that details the crane with its outriggers extended outward. Provide dimensions showing how rigging operations will affect the road and parking lines being used, the type of crane and its specification including crane arm height, lift capacity, crane reach.

B. Reports

1. Compliance with listings and approvals for equipment and for fire ratings.
2. Acceptance certificates from inspecting agencies.
3. Complete printed and illustrated operating instructions in report format.
4. Manufacturer's performance tests of equipment.
5. Field pipe and duct testing reports.
6. Field operating test results for equipment.
7. Performance report on the balancing of air and water systems.
8. Performance reports for vibration isolation equipment.
9. Manufacturer's reports on motorized equipment alignment and installation.

C. Specific references to any article, device, product or material, fixture or item of equipment by name, make or catalog number shall be interpreted as establishing a basis of cost and a standard of quality. All devices shall be of the make and type listed by Special Agencies, such as the Underwriters' Laboratories, and where required, approved by the Owner.

1.13 SPACE ALLOTMENTS AND SUBSTITUTIONS

A. The space allotments and equipment layouts on the Drawings are based on the manufacturer's model indicated or scheduled as the "Basis of Design". Ensure that any equipment that is submitted other than the "Basis of Design" will fit in the space allotment and will provide the necessary maintenance clearances as recommended by the manufacturer. If maintenance clearances are not met, pay for any changes such that maintenance clearances will be met.

B. Bear all costs associated with re-layout of the equipment, changes to piping/ductwork, and other changes as required if approved equipment other than the "Basis of Design" equipment is purchased. This shall also include any structural steel modifications and structural steel design changes. Submit, at no cost to the Owner, a steel design stamped by a structural engineer licensed in the state in which the Work is to be performed for structural modifications that must be made resulting from the use of equipment other than the "Basis of Design" or not specified.

1.14 PAINTING

A. Prime paint all bare supplemental steel, supports and hangers required for the installation of Division 15 Work in accordance with "Painting" Specification Section. Touch up welds of galvanized surfaces with galvanizing primer.

1.15 MATERIAL SAFETY DATA SHEETS

A. Submit material safety data sheets (MSDS or SDS) for all chemicals, hydraulic fluids, seal oils, lubricating oils, glycols and any other hazardous materials used in the performance of the Work, in accordance with the US Department of Labor, Occupational Safety and Health Administration (OSHA) hazard communication and right-to-know requirements stipulated in 29 CFR 1910.1200 (g).

1.16 MOTORS AND STARTERS

A. Provide new NEMA Standard electric motors, sized and designed to operate at full load and full speed continuously without causing noise, vibration, and temperature rise in excess of their rating. Provide motors with a service factor of at least 1.15.

B. Equip motors for belt driven equipment with rails with adjusting screws for belt tension adjustment. Weather protect motors exposed to the weather.

C. Install high efficiency electric motors for air handling units, relief fans, and exhaust fans.

D. Provide all motors for use with Variable Frequency Drives with "high efficiency inverter duty" insulation class "F" with class "B" temperature rise and that conform to or exceed the International Energy Conservation Code or the Federal EP Act of 1992 requirements for efficiency.

E. Provide stainless steel nameplates, permanently attached to the motor, and having the following information as a minimum:
   1. Manufacturer
   2. Type
   3. Model
   4. Horsepower
   5. Service Factor
   6. RPM
   7. Voltage/Phase/Frequency
   8. Enclosure Type
   9. Frame Size
   10. Full-Load Current
   11. UL Label (where applicable)
   12. Lead Connection Diagram
   13. Bearing Data
   14. Efficiency at Full Load.

F. Provide motors whose sound power levels do not exceed that recommended in NEMA MG 1-12.49.

G. Provide motors with drive shafts long enough to extend completely through belt sheaves when sheaves are properly aligned and balanced.

H. Protect motor starters on equipment located outdoors in weatherproof NEMA 4X enclosures.

I. Provide weatherproof NEMA 4X disconnect switches when located outdoors.

J. Motor Characteristics:
   1. As called for in the Equipment Specification Sections and on the Equipment Schedules.

1.17 ACOUSTICAL PERFORMANCE OF EQUIPMENT AND SYSTEMS

A. Install the Work in such a manner that noise levels from operation of motor driven equipment, whether airborne or structure-borne, and noise levels created by or within air handling equipment and air distribution and control media, do not to exceed sound pressure levels determined by the noise criteria curves published in the ASHRAE guide.

B. Acoustical Tests
   1. Owner may direct the Contractor to conduct sound tests for those areas the Owner deems too noisy.
   2. If NC level exceeds the requirements of the Contract Documents due to improper installation or operation of mechanical systems, make changes or repairs to bring noise levels to within required levels.
   3. Retest until specified criteria have been met.

1.18 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Instructions and Demonstration for Owner's Personnel
   1. Provide operating and maintenance instruction to the Owner when project is completed and all HVAC equipment serving the building is ready to be turned over to the Owner.
   2. Turn over the HVAC equipment to the Owner only after the final testing and proper balancing of HVAC systems.
   3. Instruct the Owner's personnel in the use, operation and maintenance of all equipment of each system.
   4. The above instruction requirements are in addition to that specified for specific equipment or systems. Conform to specified requirements if more stringent or longer instruction is specified for specific equipment or systems.

1.19 CODES, RULES, PERMITS & FEES

A. Give all necessary notices, obtain all permits and pay all government sales taxes, fees, and other costs, in connection with the Work. Unless indicated otherwise, fees for all utility connections, extensions, and tap fees for water, storm, sewer, gas, telephone, and electricity will be paid directly to utility companies and/or agencies by the Owner. File all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments having jurisdiction; obtain all required certificates of inspection for the Work and deliver same to the Owner's Representative before request for acceptance and final payment for the Work.

B. Conform to the requirements of the NFPA, NEC, FM, UL and any other local or State codes which may govern.

1.20 RECORD DRAWINGS

A. During the progress of the Work, make a record set of drawings of all changes by which the actual installation differs from the Drawings.

B. Create all record drawings in AutoCAD version 2020 or later in .dwg format. Upon completion of the Work, submit a digital copy (PDF) to the Engineer for approval of the record drawings, of the same size as the Drawings for approval. Upon approval by the Engineer furnish the Owner a digital copy (PDF) of the record drawings along with one hard copy for the Owner's records.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 CLEANING AND ADJUSTING

A. Cleaning
   1. Blow out, clean and flush each system of piping and equipment, to thoroughly clean the systems.
   2. Clean all materials and equipment; leave in condition ready to operate and ready to receive final finishes where required.
   3. Clean the operating equipment and systems to be dust free inside and out.
   4. Clean concealed and unoccupied areas such as plenums, pipe and duct spaces and equipment rooms to be free of rubbish and dust.

B. Adjusting
   1. Adjust and align equipment interconnected with couplings or belts.
   2. Adjust valves of all types and operating equipment of all types to provide proper operation.
   3. Clean all strainers after system cleaning and flushing and again before system startup.

C. Lubrication
   1. Lubricate equipment as recommended by the manufacturer, during temporary construction use.
   2. Provide complete lubrication just prior to acceptance.

D. Permanent Equipment Operating During Construction
   1. Use only in same service as the permanent applications.
   2. Use disposable filters during temporary operation.
   3. Replace expendable media, including belts used for temporary operation and similar materials just prior to acceptance of the Work.
   4. Repack packing in equipment operated during construction just prior to system acceptance, using materials and methods specified by the equipment manufacturer.

E. Retouch or repaint equipment furnished with factory finish as required to provide same appearance as new.

F. Tools
   1. Provide one set of specialized or non-standard maintenance tools and devices required for servicing the installed equipment.

3.02 EQUIPMENT BASES, PLATFORMS AND SUPPORTS

A. Provide supporting platforms, steel supports, anchor bolts, inserts, etc., for all equipment and apparatus provided.

B. Obtain prior approval for installation method of structural steel required to frame into building structural members for the proper support of equipment, conduit, etc. Welding will be permitted only when approved by the Architect/Engineer.

C. Submit shop drawings of supports to the Architect/Engineer for approval before fabricating or constructing.

D. Provide leveling channels, anchor bolts, complete with nuts and washers, for all apparatus and equipment secured to concrete pads and further supply exact information and dimensions for the location of these leveling channels, anchor bolts, inserts, concrete bases and pads.

E. Where supports are on concrete construction, take care not to weaken concrete or penetrate waterproofing.

3.03 ACCESSIBILITY

A. Install valves, dampers and other items requiring access conveniently and accessibly located with reference to the finished building.

3.04 USE OF EQUIPMENT

A. The use of any equipment, or any part thereof, even with the Owner's consent, is not an indication of acceptance of the Work on the part of the Owner, nor shall it be construed to obligate the Owner in any way to accept improper work or defective materials.

3.05 MODIFICATIONS OF EXISTING WORK

A. Coordinate the Work with all other contractors and provide necessary dimensions for all openings. Provide all cuts and openings which are necessary for the Work for passage of piping and ductwork

B. Upon completion, remove all temporary piping and equipment, shoring, scaffolds, etc., and leave all areas clean and free from material and debris resulting from the Work performed under this Section. Provide rough patching in areas required.

3.06 EQUIPMENT INSTALLATION

A. Locate and set equipment anchor bolts, dowels and aligning devices for equipment requiring them.

B. Level and shim the equipment; coordinate and oversee the grouting work.

C. Perform field assembly, installation and alignment of equipment under direct supervision provided by the manufacturer or with inspections, adjustments and approval by the manufacturer.

D. Alignment and Lubrication Certification for Motor Driven Apparatus
   1. After permanent installation has been made and connections have been completed, but before the equipment is continuously operated, have a qualified representative of the equipment manufacturer inspect the installation and report in writing on the manufacturer's letterhead on the following:
      a. Whether shaft, bearing, seal, coupling, and belt drive alignment and doweling is within the manufacturer's required tolerances so that the equipment will remain aligned in the normal service intended by the Contract Documents and that no strain or distortion will occur in normal service.
      b. That all parts of the apparatus are properly lubricated for operation.
      c. That the installation is in accordance with manufacturer's instructions.
      d. That suitable maintenance and operating instructions have been provided for the Owner's use.
      e. Make any corrections to items that are required or recommended based on the manufacturer's inspection and have the equipment re-inspected.

E. Belt Drives
   1. V-belt drives - a driving and driven sheave grooved for belts of trapezoidal cross-section. Construct belts of fabric and rubber so designed so as not to touch the bottom of the grooves, the power being transmitted by the contact between the belts and V-shaped groove sides. Design drives for a minimum of 150 percent of motor horsepower. Provide companion type driven sheaves.
   2. Select drives to provide for 12-1/2 percent variation in speed, plus or minus, from specified speed. Provide all motors with adjustable sheaves except where indicated otherwise in the Specifications or on the Drawings.
   3. Install all fans with adjustable pitch sheaves on their drive motors. Select sheaves to provide air quantities under specified conditions. Put air systems into operation, and determine as a result of the completed air balance the actual size of sheaves required to produce specified air quantities on installed systems. The adjustable pitch sheaves shall then be replaced with the proper size fixed sheaves. Remove adjustable pitch sheaves from premises. Provide fixed motor sheaves manufactured by Wood's.
   4. Where indicated on the Drawings or specified, provide spare motor, bearings, and belts.

F. Machinery Guards
   1. Protect motor drives by guards furnished by the equipment manufacturer or in accordance with the Sheet Metal and Air Conditioning Contractors National Association's (SMACNA) Low Pressure Duct Manual. Provide guards of all types approved as acceptable under OSHA Standards.

G. Equipment Start-up
    1. Require each equipment manufacturer to provide qualified personnel to inspect and approve equipment and installation and to supervise the start-up of the equipment and to supervise the operating tests of the equipment.
    2. If a minimum number of hours for start-up and instruction are not stated with the equipment specifications, these shall be two (2) full 8-hour working days as a minimum.
    3. Advise Owner of start-up at least 72 hours in advance.

3.07 CLOSEOUT PROCEDURES

A. Field Review and Punchlist:
    1. Contractor shall submit a notification to engineer for a review of completed piping work prior to application of insulation. The intent of this review is to help identify any issues prior to applying insulation. This review shall not be considered a final punchlist or remove any responsibility from contractor of contractural, code or construction requirements or system performance.
    2. Contractor shall submit a notification to engineer for a review of completed work located in concealed spaces/ceiling plenums, prior to installation of ceilings. This review shall not be considered a final punchlist or remove any responsibility from contractor of contractural, code or construction requirements or system performance.
    3. Contractor shall submit written notice of substantial completion prior to requesting 'Substantial Completion Punchlist Inspection'.
    4. Contractor shall submit all air and hydronic test balance reports a minimum of 5 days prior to requesting punchlist inspection. The reports shall be complete for all subject equipment. If any reports are missing or incomplete, contractor shall identify those items and provide a schedule of balancing completion and excepted report submission.
    5. As applicable, contractor shall provide written record of successful piping pressure test for each piping system, on company letterhead, with required data per specification, duration of test, and photographic evidence of gauge at test pressure.
        a. The contractor shall provide a written response to the punchlist items within 2 weeks of receipt of punchlist with a schedule of completion of the open items (or commentary if discussion or objection are raised).
    6. If contractor requests a punchlist inspection and engineer finds incomplete work within the work claimed to be substantially complete, the engineer will inform the contractor and may (at engineer's choice) terminate the inspection prior to reviewing all work. The Contractor will be responsible for reimbursing engineer for subsequent punchlist activities.
    7. Upon receipt of engineer's punchlist inspection report, the contractor shall respond to each comment with an acknowledgement of each item (initialled, dated and photo evidence of completed work) or disagreement and written explanation of disagreement.
    8. The contactor may respond with acknowledgement by providing photo of corrective action, or at the engineer's choice and upon contractor's written

confirmation that all punchlist items have been addressed, may request a final punchlist inspection.

B. General Operating and Maintenance Instructions: Arrange for each installer of operating equipment and other work that requires regular or continuing maintenance, to meet at the site with the Owner's personnel to provide necessary basic instructions in the proper operation and maintenance of the entire Work. Where installers are not expert in the required procedures, include instruction by the manufacturer's representatives.

C. Where applicable, provide instruction and training, including application of special coatings systems, at manufacturer's recommendation.

D. Provide a detailed review of the following items:
   1. Maintenance manuals
   2. Record documents and catalog cuts for each piece of equipment.
   3. Spare parts and materials
   4. Tools
   5. Lubricants
   6. Fuels
   7. Identification systems
   8. Control sequences
   9. Hazards
   10. Cleaning

E. Warranties, bonds, maintenance agreements, and similar continuing commitments.

F. Demonstrate the following procedures:
   1. Start-up
   2. Shut-down
   3. Emergency operations
   4. Noise and vibration adjustments
   5. Safety procedures
   6. Economy and efficiency adjustments
   7. Effective energy utilization.

G. Prepare instruction periods to consist of approximately 50% classroom instruction and 50% "hands-on" instruction. Provide minimum instruction periods as follows:

Systems or Equipment	Training Time (Hours)
Exhaust Fans and Louvers	5 hrs.
Air-to-Water Heat Pumps	5 hrs.
Water-to-Water Heat Pumps	4 hrs.
Hydronic Pumps and Unit Heaters	4 hrs.
Hydronic Accessories and Valves	3 hrs.
Electrical Room Air Conditioners	4 hrs.
Variable Refrigerant Flow Split Units	3 hrs.
Airflow Monitoring Panels	3 hrs.

Note: Consult individual equipment specification sections for additional training requirements.

H. Prepare a written agenda for each session and submit for review and approval. Include date, location, purpose, specific scope, proposed attendance and session duration.

I. Record training sessions in digital format, format as selected by the Owner. Turn over digital files to the Owner after training has been completed.

+ + END OF SECTION + +

SECTION 15001

COMMISSIONING OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.01 COMMISSIONING CONTRACT

A. The Owner will employ an independent Commissioning Authority (CA). The mechanical contractor shall support all commissioning efforts as defined here-in and as required by the CA, in reference specifications or as otherwise required under standard care of the type of project and it's delivery.

1.02 DESCRIPTION

A. General provisions and other mechanical systems are specified in other Sections of Division 15.

B. Commissioning is an ongoing process and shall be performed throughout construction. Commissioning requires the participation of Division 15 to ensure that all systems are operating in a manner consistent with the Contract Documents. Division 15 shall be familiar with the commissioning plan issued by the Commissioning Authority (CA) as it applies to the work of Division 15 and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

C. Commissioning shall conclude with the completion of all required deferred testing, training and system documentation as specified and required to ensure the proper operation of the mechanical equipment and systems provided by this Division.

D. This Section covers mechanical systems commissioning, as required to demonstrate that the equipment and systems of Division 15 are ready for safe and satisfactory operation, as defined by project documents. Commissioning shall include, but shall not be limited to, identification of piping and equipment, cleaning, lubrication, start-up, check-out, and testing, adjusting, and balancing of systems, preparation of equipment and systems documentation and of maintenance and operation manuals, Owner training, and preparation of record drawings.

1.03 QUALITY ASSURANCE

A. The mechanical contractor shall identify a mechanical commissioning supervisor. The mechanical commissioning supervisor should have a minimum of ten years experience in mechanical contracting. The mechanical commissioning supervisor shall become familiar with the design intent and the requirements of the commissioning process as defined in this Section. The mechanical commissioning supervisor shall attend all commissioning meetings and coordinate the commissioning schedule as outlined by the

CA. The mechanical commissioning supervisor shall assist the CA in coordinating and executing the required commissioning activities.

1.04 MECHANICAL CONTRACTOR RESPONSIBILITIES

A. Include and itemize the cost of commissioning in the contract price with an estimated breakdown of hours for meeting and functional testing requirements.

B. The mechanical commissioning supervisor shall be responsible for scheduling, supervising, and coordinating the startup, testing and commissioning activities as specified herein with the CA. Specific requirements of the mechanical contractor and associated subcontractors are identified in this Section and in other Sections of this Division.

C. The CA shall conduct independent verification of installation, pre-functional, start-up and functional testing as required here-in.

D. Mechanical commissioning shall take place in three phases. Commissioning requirements for each phase are as follows:
   1. Construction Phase
      a. The Contractor shall attend a Commissioning Scoping meeting and additional commissioning meetings as required throughout the commissioning process. These commissioning meetings will be monthly during early construction and may increase in frequency to weekly during the start-up, pre-functional and functional testing phases. The Contractor shall assure that all subcontractors who have commissioning responsibilities attend the Commissioning Scoping meeting and other commissioning meetings, as appropriate, during the construction process.
      b. The Contractor shall report, in writing, to the CA at least as often as commissioning meetings are scheduled concerning the status of his activities as they affect the commissioning process, the status of each discrepancy identified, the pre-functional and functional testing process, explanations of any disagreements with the identified deficiencies, and proposed resolution and schedule.
      c. The Contractor shall provide the CA with normal cut sheets and shop drawing submittals of equipment that is to be commissioned.
      d. The Contractor shall provide documentation to the CA for development of pre-functional and functional performance testing procedures, prior to normal O&M manual submittals. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any owner-contracted tests; fan and pump curves; full factory testing reports, if any; and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CA. The CA may request further documentation necessary for the

development of functional performance testing and the commissioning process. This data request may be made prior to normal submittals.

e. The Contractor shall develop and submit to CA, for review prior to equipment or system startup, a complete startup and initial checkout plan using manufacturer's start-up procedures.
f. The Contractor shall review and complete the CA's pre-functional check-sheets and sign-off on the appropriate areas when the Contractor and sub-contractors are complete. The pre-functional test sheets will be developed by the CA. The CA may conduct their own pre-functional testing check in parallel with the Contractors or verify the contractors completed pre-functional forms after submission.
g. The Contractor shall provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review.
h. The Contractor shall assist in clarifying the proposed operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
i. The CA shall prepare the specific functional test procedures as specified herein. The Contractors shall review the CA's proposed functional performance test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
j. Contractor shall prepare a preliminary schedule for Division 15 commissioning activities, to include pipe and duct system testing, flushing and cleaning, equipment start-up, and TAB start and completion, for use by the CA and shall update the schedule as appropriate. CA will assist in providing expected time durations for Cx activities.
k. The Contractor shall update the commissioning activities and notify any delays in the progress meetings. Contractor shall notify the CA during the commissioning meetings when commissioning activities not yet performed or not yet scheduled will delay construction. Mechanical equipment start-up shall not be initiated until the complete sign-off of the pre-functional check-sheets as developed by the CA as specified in other Sections of Division 15.
l. The Contractor shall provide startup testing for all HVAC equipment, including the building automation control system and shall execute the mechanical-related portions of the pre-functional checklists for all commissioned equipment during the startup and initial checkout process. The CA shall conduct an independent start-up once the Contractor is complete with their requirements.
m. The Contractor shall perform and clearly document all completed start-up and system operational checkout procedures, providing a copy to the CA.
n. The Contractor shall correct current A/E punch list and CA deficiency items before functional performance testing can begin. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air or water related systems.

o. The CA shall generate the functional testing procedure and record to the mechanical contractor. The mechanical contractor shall review and provide support to the functional testing process. Contractor shall operate boilers, pumps, etc., and systems in accordance with the CA requirements, open and close disconnects and switch normal and emergency power requirements as directed by the CA and the functional testing procedures.

p. The Contractor shall report in writing to the CA at least as often as commissioning meetings are being scheduled concerning the status of each outstanding discrepancy identified during commissioning, pre-functional and functional performance testing. Report shall include description of the identified discrepancy, explanations of any disagreements, and proposals and schedule for correction of the discrepancy.

1) Acceptance Phase. The Contractor shall assist and cooperate with the CA in the commissioning process by:

(a) Putting all HVAC equipment and systems into operation and continuing the operation during each working day of the test and balance and commissioning effort, as required.

(b) For a given area, have all required pre-functional checklists, calibrations, startup and selected functional tests of the mechanical system and associated controls completed and approved by the CA prior to beginning the test and balance process.

(c) Provide a qualified technician to operate the controls as required to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

(d) Provide a TAB representative to assist the CA on conducting a random 10% check of the air and water distribution requirements.

(e) Including cost of sheaves and belts that may be required to obtain required equipment performance, as measured by the test and balance effort.

(f) Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.

(g) Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.

(h) Installing a P/T plug at each water sensor that is an input point to the Control System.

(i) Providing skilled technicians to execute starting and operation of equipment.

(j) The CA will conduct functional performance testing. The Contractor may be required to have a skilled technician present during functional testing, although it is suggested that one be available to make adjustments or assist in problem-solving.

(k) The CA will require full and part load performance verifications as well as seasonal and simulated testing requirements. The Contractor shall be prepared to operate different components of various systems

(example, DX and hot water systems to generate loading strategies) during the functional testing.

(l) Correct deficiencies (differences between specified and observed performance) as interpreted by the CA and A/E.

(m) Prepare O&M manuals according to the Contractor Documents, including clarifying and updating the original sequence of operation to as-built conditions.

(n) Maintain on site redline as built drawings and produce final "As-built" drawings for all project drawings and contractor-generated coordination drawings. List and clearly identify on the as-built drawings the locations of all airflow stations and sensor installations that are not equipment mounted.

(o) Provide specified training of the Owner's operating personnel in accordance with the CA's overview and outline.

(p) Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

(q) Provide updated diagrammatical logic for all TAB adjustments to the system.

2) Warranty Period. During the warranty period, the Contractor shall:

(a) Be available during seasonal or deferred functional performance testing conducted by the CA, according to the specifications.

(b) Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

1.05 TAB CONTRACTOR RESPONSIBILITIES

A. Six weeks prior to the starting of the T&B, submit to the CA, the qualifications of the site technician(s) for the project, including three (3) names of contractors and facility managers of recent projects on which the personnel were in charge. The Owner and CA will approve the site technician for this job.

B. Three months prior to the start of the TAB, submit a TAB plan and approach for each system. The plan shall be reviewed by the TAB and the CA for review and approval. The submitted plan shall include:

1. Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and Contractors to sufficiently understand the design intent for each system.
2. An explanation of the intended use of the building control system.
3. All field check-out sheets and logs to be used that lists each piece of equipment to be tested adjusted and balanced with the data cells to be gathered for each.
4. Final test report forms to be used during this process:
   a. Detailed step by step procedures for TAB work for each system and issue: terminal flow calibration; diffuser proportioning; branch and submain proportioning; total flow calculations; and rechecking diversity issues.

b. List all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of each of the test procedures, parameters and formulas to be used.
c. Details of how total flow will be determined (Air: sum of terminal flows via BMS calibrated readings or via hood, pitot tube or flow stations). Details of how total water flow will be determined (Water: pump curves, circuit setters, flow station, ultrasonic, etc.).
d. The identification and types of measurement instruments to be used and their most recent calibration date.
e. Specific procedures that will ensure that both air and watersides will be operating at there lowest possible pressure at the point where the system will operate.
f. Confirmation that the TAB contractor understands the outside air ventilation criteria under all conditions and how this will be measured during normal, economizer and unoccupied conditions.
g. Details of how building static, room static and exhaust fan capacity will be checked.
h. Proposed selection points for traverse measurement locations on the as-built documents. Review the placement of the HVAC measurement devices for proper straight runs and accuracy.
i. Submit a plan for testing and checking the fume hood system exhaust requirements.
j. Plan for formal progress reports including scope and frequency.
k. Plan for formal deficiency reports including scope and frequency.
    1) TAB contractor shall attend commissioning meetings as directed by the CA and the general contractor.
    2) TAB contractor shall communicate in writing to the controls contractor and the CA all setpoint and parameter changes made or problems and discrepancies identified during the TAB process that would affect the control loop system set-up and operation.
    3) Submit written report of discrepancies, deficit or uncompleted work by others, contract interpretation requests and list of completed tests to the CA at least once per week.
    4) After the TAB plan is accepted and two-weeks prior to TAB work, the contractor shall conduct a pre-balancing conference. Prior to the pre-balancing conference, the TAB contractor shall inspect the system readiness for testing and balancing. The TAB contractor shall prepare a list of deficiencies and uncompleted work that will affect the TAB process. This list shall be submitted to the CA and the general contractor.
    5) The TAB contractor shall review the projected schedule and provide, in writing, to the CA and CM any delays in the schedule and what items will require completion prior to the TAB work.
    6) The CA agent shall conduct independent verification of 10% of air and water end-devices for acceptance after the TAB contractor states in writing that they are complete with Testing & Balancing. The TAB

contractor shall provide a mechanic to assist the CA in this verification and shall include this in the scope and price of the Work.

7) The TAB agent shall submit the TAB report to the CA for his review and comment. All data contained shall be re-verified in the field by the CA. A minimum of ten percent of the airflow readings shall be verified by the CA using his own equipment. All selection points shall be random. Total airflow shall be verified on all mains in the supply and the exhaust ducts.

1.06 CONTROL CONTRACTOR RESPONSIBILITIES

A. Include and itemize the cost of commissioning in the contract price with an estimated breakdown of hours for meeting and functional testing requirements.

B. The controls commissioning supervisor shall be responsible for scheduling, supervising, and coordinating the startup, testing and commissioning activities as specified herein with the CA. Specific requirements of the controls contractor and associated subcontractors are identified in this Section and in other Sections of this Division.

C. The CA shall conduct independent verification of installation, pre-functional, start-up and functional testing as required here-in.

D. Controls commissioning shall take place in three phases. Commissioning requirements for each phase are as follows:
   1. Construction Phase
      a. Contractor shall attend a Commissioning Scope meeting and additional commissioning meetings as required throughout the commissioning process. These commissioning meetings will be monthly during early construction and increase in frequency to weekly during the start-up, pre-functional and functional testing phases. Contractor shall assure that all subcontractors who have commissioning responsibilities attend the Commissioning Scope meeting and other commissioning meetings, as appropriate, during the construction process.
      b. Contractor shall report, in writing, to the CA at least as often as commissioning meetings are scheduled concerning the status of his activities as they affect the commissioning process, the status of each discrepancy identified, the pre-functional and functional testing process, explanations of any disagreements with the identified deficiencies, and proposed resolution and schedule.
      c. Contractor shall provide the CA with normal cut sheets and shop drawing submittals of equipment that is to be commissioned.
      d. Contractor shall provide documentation to the CA for development of pre-functional and functional performance testing procedures, prior to normal O&M manual submittals. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any owner-contracted tests; points listing; full factory testing reports, if any; and full warranty information,

including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CA. The CA may request further documentation necessary for the development of functional performance testing and the commissioning process. This data request may be made prior to normal submittals.

e. The Contractor shall develop and submit to CA, for review prior to equipment or system startup, a complete startup and initial checkout plan using manufacturer's start-up procedures.
f. The Contractor shall review and complete the CA's pre-functional check-sheets and sign-off on the appropriate areas when the Contractor and sub-contractors are complete. The pre-functional test sheets will be developed by the CA. The CA may conduct their own pre-functional testing check in parallel with the Contractors or verify the contractors completed pre-functional forms after submission.
g. Contractor shall provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review.
h. Contractor shall assist in clarifying the proposed operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
i. CA shall prepare for the specific functional test procedures as specified herein. The Contractors shall review the CA's proposed functional performance test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
j. Controls contractor shall prepare a preliminary schedule for their commissioning activities, to include wiring, instrument installation, calibration, point-to-point verification, sequence of operation testing and emergency operating procedural testing for use by the CA and shall update the schedule as appropriate. The Contractor shall update the commissioning activities and notify any delays in the progress meetings. Contractor shall notify the CA during the commissioning meetings when commissioning activities not yet performed or not yet scheduled will delay construction.
k. Controls instrument and equipment start-up shall not be initiated until the complete sign-off of the pre-functional check-sheets as developed by the CA as specified in other Sections of Division 15.
l. Contractor shall provide startup testing for all HVAC equipment, including the building automation control system and shall execute the mechanical/controls-related portions of the pre-functional checklists for all commissioned equipment during the startup and initial checkout process. The CA shall conduct an independent start-up once the Contractor is complete with their requirements.
m. Contractor shall perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.

n. Contractor shall correct current A/E punch list and CA deficiency items before functional performance testing can begin. Point-to-point verification shall be completed with discrepancies and problems remedied before functional testing of the respective controls related systems.

o. The CA shall generate the functional testing procedure and record to the controls contractor. The controls contractor shall review and provide support to the functional testing process. Contractor shall aid in operating boilers, pumps, etc., and systems in accordance with the CA requirements, turn on and off normal and emergency power requirements as directed by the CA and the functional testing procedures.

p. Contractor shall report, in writing, to the CA at least as often as commissioning meetings are being scheduled concerning the status of each outstanding discrepancy identified during commissioning, pre-functional and functional performance testing. Report shall include description of the identified discrepancy, explanations of any disagreements, and proposals and schedule for correction of the discrepancy.

    1) Acceptance Phase. Contractor shall assist and cooperate with the CA in the commissioning process by:
        (a) Putting all HVAC equipment and systems into operation and continuing the operation during each working day of the test and balance and commissioning effort, as required.
        (b) For a given area, have all required, pre-functional checklists, calibrations, startup and selected functional tests of the mechanical system and associated controls completed and approved by the CA prior to beginning the test and balance process.
        (c) Provide a qualified technician to operate the controls as required to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.
        (d) Provide a controls representative to assist the CA on conducting a random 10% check of the air and water distribution requirements.
        (e) Providing skilled technicians to execute starting and operation of equipment.
        (f) The CA will conduct functional performance testing. The Contractor may be required to have a skilled technician present during functional testing, although it is suggested that one be available to make adjustments or assist in problem-solving.
        (g) The CA will require full and part load performance verifications as well as seasonal and simulated testing requirements. The Contractor shall be prepared to operate different components of various systems (example, chilled water and hot water systems to generate loading strategies) during the functional testing.
        (h) Correct deficiencies (differences between specified and observed performance) as interpreted by the CA and A/E.
        (i) Prepare O&M manuals according to the Contractor Documents, including clarifying and updating the original sequence of operation to as-built conditions.

(j) Maintain on site redline as built drawings and produce final "As-built" drawings for all project drawings and contractor-generated coordination drawings. List and clearly identify on the as-built drawings the locations of all airflow stations and sensor installations that are not equipment mounted.
(k) Provide specified training of the Owner's operating personnel in accordance with the CA's overview and outline.
(l) Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
(m) Provide a detailed marked up drawings of all the instruments and their installed location (P&ID) for instruments and components.

2) Warranty Period. During the warranty period, the Contractor shall:
(a) Be available during seasonal or deferred functional performance testing conducted by the CA, according to the specifications.
(b) Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

PART 2 - PRODUCTS

2.01 SYSTEMS TO BE COMMISSIONED

A. The following are systems to be commissioned:
1. Exhaust Fans
2. Motorized Dampers
3. Exhaust Fan Control Panel
4. Air-to-Water Heat Pumps
5. Water-to-Water Heat Pumps
6. Hydronic Pumps
7. Hydronic Unit Heaters
8. Blower Oil-to-Water Coolers Piping/Devices
9. Hydronic Control Panel
10. Electrical Room Air Conditioners and Condensing Units
11. Variable Refrigerant Flow Split Systems
12. Airflow Monitoring Panel
13. Gas Detection Panel

2.02 TEST EQUIPMENT

A. All standard testing equipment required to the mechanical portion startup, initial checkout shall be provided by the Contractor responsible for the equipment or system being tested. This includes TAB and controls verification.

B. The CA shall perform their own system verification and performance check-out. The CA shall provide their own calibrated equipment as required for this testing.

C. All testing equipment associated with functional performance verification and point-to-point required by the CA shall be the responsibility of the CA. All testing equipment associated with the control's contractor point-to-point verification shall be the responsibility of the control's contractor.

D. Special equipment, tools and instruments (only available from vendor or specific to a piece of equipment) required for the functional testing of that equipment, according to the requirements of the contract documents and the functional test procedures shall be provided to the CA by the installing contractor and shall become the property of the Owner at project completion as indicated in the specification.

E. Proprietary test equipment and software required by any manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide test equipment, demonstrate its use and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon successful completion of the commissioning process as required in the specifications.

PART 3 - EXECUTION

3.01 SUBMITTALS

A. Division 15 shall provide submittal documentation relative to commissioning as required in this Section Part 1.

3.02 STARTUP PLAN AND PREFUNCTIONAL TESTING

A. The mechanical contractor and associated subcontractors shall be responsible for the installation of complete systems and sub-systems, fully functional, meeting the design objectives of the Contract Documents. Contractor shall follow the approved start-up, initial checkout, and pre-functional testing procedures. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility to the CA or Owner.

B. Pre-functional testing as directed and performed by the contractor shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional performance testing to may proceed without delays. Sampling strategies shall not be used for pre-functional testing. The pre-functional testing for all equipment and subsystems of a given system shall be successfully completed and documented prior to functional performance testing of the system. The mechanical contractor and sub-contractors shall sign off on the CA's pre-functional test sheets that they are complete and the system is ready. The CA will verify and conduct their own independent verification and start-up in parallel to the Contractor's verification. Any deficiencies identified during this process shall be noted and reviewed by the Contractors. Start-up and functional testing shall not proceed until all the deficiencies are corrected and verified by the CA.

C. The following procedures shall apply to all equipment and systems to be commissioned.
   1. Start-up and Initial Checkout Plan. The contractor shall develop the detailed start-up and pre-functional testing plans for all equipment to be reviewed by the CA. The primary role of the CA in this process shall be to review the installation for construction completeness and ensure that all components have been installed as per the design documents. Only when pre-functional testing is complete and signed off by all Contractors, shall the Contractor start-up the equipment. Equipment and systems to be commissioned are identified in this Section Part 2.
   2. The start-up and initial checkout plan shall consist of the following as a minimum:
      a. The manufacturer's standard written start-up and checkout procedures copied from the installation manuals and manufacturer's normally used field checkout sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
      b. First-run checklist for equipment, to include:
         1) Equipment properly set.
         2) Alignment of shafts and couplings.
         3) Adjustment of vibration isolators.
         4) Piping and equipment properly connected.
         5) Completion of initial lubrication procedures.
         6) Clean filters in place, as appropriate.
         7) Wiring properly connected.
         8) Electrical overload relays appropriate for load.
         9) Electrical accessories properly installed and adjusted.
         10) Controls, safeties, and time switches properly calibrated and set-up.
         11) Verification of direction of motor rotation after final electrical connections by jogging motor.
         12) Measurements of ampere draw of electric motors and comparison with nameplate rating and with overload heater ratings.
         13) The Contractor shall submit the start-up reports to the CA for review.

D. The CA shall review and approve the procedures and the format for documenting them, noting any procedures that need to be added.

E. Two weeks prior or startup, the Contractor shall schedule start-up and checkout with the Owner and CA. The execution of the start-up and checkout shall be directed and performed by the Contractor, in accordance with manufacturer's published procedures and with the approved procedures. The CA may be present for the Contractor's required startup and checkout of all systems and equipment to be commissioned.

F. Sensor Calibration. Calibration of all sensors shall be included as part of the pre-functional testing and listed on the appropriate test checklists and reports, according to the specified procedures and accuracies for the devices and systems being tested.

G. All contractor responsible start-up, checkout forms shall be completed and submitted to the CA for review.

3.03 FUNCTIONAL PERFORMANCE TESTS

A. Functional Performance Verification (FPV) is the dynamic testing of systems (rather than just individual components) under full, part and seasonal requirements. Systems are tested under various loads and control sequences, such as low cooling and heating loads, component failures, unoccupied modes, fire alarm, etc. The systems are run through all the control sequences of operation and components are verified to be responding as the design intent and documents. FPV shall include; testing all sequences of operations, verification of system capacity, generating simulated signals to simulate sensor values, conducting simulated conditions to tests all loads and verify system performance during all conditions of operation and verifying design intent. In addition, each system shall be tested through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part and full load). Proper responses such as power failures, freeze conditions, low-oil pressures, equipment failures, etc. shall also be tested. The CA develops the functional test sheets and procedures in sequential written form, coordinates the testing, conducts the testing and documents the testing. Each contractor is required is supply personnel to assist during the functional performance testing where applicable.

B. No system, equipment or component thereof shall be tested until the Contractor and the CM has certified, in writing, that the system, equipment and / or components are complete, have been tested, adjusted and balanced and are ready for validating and performance testing. FPV is scheduled by the CA after the pre-functional testing requirements are complete and signed-off by the CM and the CA. FPV will not be conducted until a written notice of completion by the CM confirming that the system is ready for FPV. The air balancing and water balancing must be complete and the controls must be debugged prior to the performance verification.

C. Functional testing shall be conducted by the CA. Functional testing may not proceed until the systems have been properly installed, started-up and all deficiencies have been corrected.

D. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA and CM. Beginning system testing before full completion shall not relieve the Contractor from fully completing the system, including all pre-functional checklists.

E. The Contractor shall provide personnel to operate the systems while functional performance testing is commencing. This shall include but not be limited to; starting and stopping of systems, opening and closing valves to create false loads on the system (with the capabilities of the existing system) and allowing the CA to manipulate the building automation systems to modulate the system requirements.

F. The Contractor shall review the commissioning functional performance testing procedure supplied by the CA. After functional testing commences, the Contractor and

the CA shall sign the functional test record and provide the owner and the CM a copy to review. All deficiencies either corrected in the field or outstanding shall be documented on the functional test forms for review by all parties.

G. All functional testing must be completed and approved by the CA and the owner before the project will be considered substantially complete.

3.04 DEFERRED TESTING

A. Deferred Testing. The Contractor shall be available to assist in seasonal testing (Summer, Winter and Intermediate), tests delayed until weather or other conditions until building construction is completed, required building occupancy or loading, or other conditions are suitable for the demonstration of equipment or system's performance, as specified. These deferred tests shall be conducted in the same manner as the seasonal tests as soon as possible. Deferred testing shall be executed, documented and deficiencies corrected as specified herein for functional performance testing. Any adjustments or corrections to the O&M manuals and "As built" documents required by the results of the testing shall be made before the seasonal testing process is considered complete.

3.05 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

A. The CA shall clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully. The testing form and any outstanding deficiencies shall be provided to the CM/Owner within two days of test completion. The CA shall review the Contractor's startup testing reports and shall submit either a non-compliance report or an approval form to the Contractor. The CA shall work with the Contractor and others as necessary, to correct and retest deficiencies or uncompleted items. The Contractor shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated start-up report with a Statement of Correction on the original non-compliance report. When all requirements are satisfactorily completed, the CA shall recommend approval of the startup and pre-functional testing of each system and schedule the functional testing of the equipment or system.

B. As functional performance testing progresses and a deficiency is identified, the CA shall discuss the issue with the executing contractor and the commissioning team.
   1. When there is no dispute of the deficiency and the Contractor accepts responsibility for correcting it, the CA shall document the deficiency and the Contractor's response and intentions and the testing shall proceed, if possible. Corrections of minor deficiencies identified may be made by the Contractor during the functional performance testing, at the discretion of the CA. Every effort shall be made or expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the commissioning effort.
   2. When the identified deficiency is corrected, the Contractor shall sign the statement of correction at the bottom of the non-compliance form, certifying that the

equipment is ready to be retested, and return the form to the CA. The CA shall schedule the retest of the equipment or system involved.

3. If there is a dispute about an identified deficiency, the CA shall document the deficiency and the Contractor's response, and provide a copy to the Contractor. Every attempt shall be made to resolve the dispute at the lowest management level possible. When the dispute resolution has been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and returns the form to the CA. The CA shall schedule the retest of the equipment or system involved. Final interpretive authority shall be the A/E. Final acceptance authority shall be the Owner.

C. During the functional performance testing of multiple units of similar equipment, the CA will test all of the installed equipment and components identified. If, under such a testing procedure, three or more identical pieces of equipment (size along does not constitute difference) fail to perform to the requirements of the Contract Documents (mechanically or substantively) due to manufacturing or installation defects not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the CA. In such a case, the Contractor shall provide the CA with the following:

1. Within one week of notification from the CA, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CA within two weeks of the original notice.
2. Within two weeks of the original notification, the Contractor shall provide the CA and the A/E a signed and dated, written explanation of the problem, cause of failures, etc., and proposed solution, including full equipment submittals for corrective or replacement equipment, if appropriate. The proposed solution shall not be for less than the specification requirements of the original installation.
3. When approved, two examples of the proposed solution shall be installed by the Contractor and the CA shall schedule and conduct functional testing of the proposed solution. Upon completion of the functional testing of the proposed solution, the CA shall recommend the acceptance or disapproval of the proposed solution to the Owner.
4. Upon acceptance of the proposed solution by the Owner, the Contractor shall replace or repair all identical items, at their expenses and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week of approval of the proposed solution.
5. Cost of Retesting
    a. The cost for CA and/or Owner personnel to conduct the retesting of a functional performance testing requirements necessitated because a specific pre-functional or start-up test item, reported to have been successfully completed, but found to be incomplete or faulty, shall be the responsibility of the Contractor.
    b. For a deficiency identified during the functional testing, not related to any pre-functional checklist or start-up fault, the CA and Owner shall direct the

retesting of the equipment once at "no charge" for their time. However, all costs for any subsequent retesting shall be the responsibility of the Contractor.

c. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back-charges to the responsible party.

3.06 OPERATION AND MAINTENANCE (O&M) MANUALS

A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.

B. Division 15 shall compile and prepare documentation for all equipment and systems covered in Division 15 and deliver this documentation to the CM for inclusion in the O&M manuals, according to this section and and other applicable section, prior to the training of owner personnel.

C. The CA shall receive a copy of the O&M manuals for review.

D. Operation and maintenance documentation, in hardback 3-ring loose-leaf binders except full size drawings and diskettes, shall cover all mechanical systems. Documentation shall include the following: operations and maintenance documentation directory; emergency information; operating manual; emergency information; maintenance manual; test reports; and construction documents.

E. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Owner and CA before systems start-up and commissioning, and shall be updated, revised and completed during, and at completion of, commissioning.

3.07 TRAINING OF OWNER PERSONNEL

A. The mechanical commissioning supervisor shall be responsible for training coordination and scheduling of required training and for ensuring that all required training is completed. The CA shall oversee the content and adequacy of the training of Owner personnel.

B. Prepare and submit a syllabus describing an overview of the program, describing how the program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from the Owner on which operating personnel shall be instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the CA for review of the content and adequacy of the training of Owner personnel for commissioned equipment or systems.

C. Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:

1. Provide the CA with training plan one week before the planned training.

2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.
3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise, as well as in-depth knowledge of all modes of operation of the specific piece of equipment, is required. More than one party may be required to execute the training.
6. The controls contractor shall attend sessions other than the controls training, for each type of equipment controlled by the BAS, to discuss the interaction of the BAS as it relates to the equipment being discussed.
7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

3.08 WRITTEN WORK PRODUCTS

A. Written work products of Contractors shall consist of the start-up and initial checkout plan and the filled out start-up, initial checkout and pre-functional checklists.

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SECTION 15051

BURIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings, and specials. The Work includes the following:
      a. All types and sizes of buried piping, except where buried piping installations are specified under other Sections.
      b. Unless otherwise shown or specified, this Section includes all buried piping Work required, beginning at the outside face of structures or structure foundations, including piping beneath structures, and extending away from structures.
      c. Work on or affecting existing buried piping.
      d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, cathodic protection, and other Work required for a complete, buried piping installation.
      e. Supports, restraints, and thrust blocks.
      f. Pipe encasements, with the exception of the following, which are specified under Section 15052, Exposed Piping Installation:
         1) Piping embedded in concrete within a structure, or
         2) Piping embedded in a foundation.
      g. Field quality control, including testing.
      h. Cleaning and disinfecting.
      i. Incorporation of valves, meters, and special items shown or specified into piping systems in accordance with the Contract Documents and as required.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before buried piping Work.
   2. Coordinate with appropriate piping Sections of Division 15, Mechanical.
   3. Refer to Section 01700, Maintenance of Plant Operations, for constrains before developing laying schedules.

C. Related Sections:
   1. Section 02200, Earthwork.
   2. Section 03300, Cast-In-Place Concrete.
   3. Section 09900, Painting.
   4. Section 15061, Ductile Iron Pipe.
   5. Section 15065, Concrete Pipe.
   6. Section 15120, Couplings, Adapters, and Specials for Piping.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM B32, Specification for Solder Metal.
   2. ANSI/AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   3. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   4. ANSI/AWWA C606, Standard for Grooved and Shouldered End Joints.

5. ANSI/AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
6. AWWA M9, Concrete Pressure Pipe.
7. AWWA M41, Ductile-Iron Pipe and Fittings.
8. ASCE 37, Design and Construction of Sanitary and Storm Sewers.
9. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements and recommendations of authorities having jurisdiction over the Work.
   2. Obtain required permits for Work in roads, rights-of-way, railroads, and other areas of the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Laying schedules for concrete pipe and piping with restrained joints.
      b. Details of piping, specials, joints, harnessing and thrust blocks, and connections to piping, structures, equipment, and appurtenances.
   2. Product Data:
      a. Manufacturer's literature and specifications, as applicable, for products specified in this Section.
   3. Testing Procedures:
      a. Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain Engineer's approval prior to commencing testing.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.
   2. Field Quality Control Submittals:
      a. Results of each specified field quality control test.

C. Closeout Submittals: Submit the following:
   1. Record Documentation:
      a. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work. Submittal shall show actual location of all piping Work and appurtenances at same scale as the Drawings.
      b. Show piping with elevations referenced to Project datum and dimensions from permanent structures. For each horizontal bend in piping, include dimensions to at least three permanent structures, when possible. For straight runs of piping provide offset dimensions as required to document piping location.
      c. Include profile drawings with buried piping record documents when the Contract Documents include piping profile drawings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.

2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.

B. Storage:
1. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
2. Pipe and fittings specefied herein may be stored outdoors without cover.

C. Handling:
1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free from dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in Table 15051-A, Buried Piping, following the "End of Section" designation. Piping materials shall conform to Specifications for each type of pipe and piping appurtenances in applicable Sections of Division 15, Mechanical.

B. General:
1. Pipe Markings:
a. Factory-mark each length of pipe and each fitting with designation conforming to those on approved laying schedules.
b. Manufacturer shall cast or paint on each length of pipe and each fitting pipe material, diameter, and pressure or thickness class.

C. Polyethylene Encasement:
1. Polyethylene may be supplied in tubes or sheets.
2. Polyethylene encasement materials shall be in accordance with ANSI/AWWA C105.

2.2 BURIED PIPING IDENTIFICATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:
1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, suitable for direct burial. Tape shall be capable of stretching to twice its original length.
2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other service as appropriate, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW", with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as pipeline colors specified for associated pipe service in Section 09900, Painting.
3. Manufacturer: Provide products of one of the following:
a. Brady Corporation
b. Seton Identification Products
c. Marking Services, Inc.
d. Or equal.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
   1. Tape shall be of inert, acid- and alkali-resistant, polyethylene, five mils thick, six inches wide, with aluminum backing, and have 15,000 psi tensile strength and 140 percent elongation capability. Tape shall be suitable for direct burial.
   2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other appropriate service, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW" with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as the pipeline colors as specified for the associated pipe service in Section 09900, Painting.
   3. Manufacturer: Provide products of one of the following:
      a. Brady Corporation
      b. Seton Identification Products
      c. Marking Services, Inc.
      d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
   2. In event of conflict between manufacturer's recommendations and the Contract Documents, request interpretation from Engineer before proceeding.
   3. Engineer will observe excavations and bedding prior to laying pipe by Contractor. Notify Engineer in advance of excavating, bedding, pipe laying, and backfilling operations.
   4. Minimum cover over buried piping shall be four feet, unless otherwise shown or approved by Engineer.
   5. Earthwork is specified in Section 02200, Earthwork.
   6. Excavation in excess of that required or shown, and that is not authorized by Engineer shall be filled at Contractor's expense with granular material furnished, placed, and compacted in accordance with Section 02200, Earthwork.
   7. Comply with NFPA 24 for "Outside Protection", where applicable to water piping systems used for fire protection.

B. Manufacturer's Installation Specialist:
   1. Provide services of competent installation specialist of pipe manufacturer when pipe installation commences for:
      a. Concrete pipe.
   2. Retain installation specialist at the Site for minimum of two days (eight hours per day at the Site) or until competency of pipe installation crew has been satisfactorily demonstrated.

C. Separation of Sewers and Potable Water Piping:
   1. Horizontal Separation:
      a. Where possible, existing and proposed potable water mains and service lines, and sanitary, combined, and storm sewers shall be separated horizontally by clear distance of at least ten feet.
      b. If local conditions preclude the specified clear horizontal separation, installation will be allowed if potable water main is in separate trench or on undistributed earth shelf on one side of sewer and with bottom of potable water main at least 18 inches above top of sewer.
      c. Exception:
         1) Where it is not possible to provide minimum horizontal separation described above, construct potable water main of cement-lined ductile iron pipe with

restrained push-on joint or restrained mechanical joint pipe complying with public water supply design standards of authority having jurisdiction. Hydrostatically test water main and sewer as specified in this Section prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.

2. Vertical Separation:
   a. Provide minimum vertical distance of 18 inches between outside of potable water main and outside of sewer when sewer crosses over potable water main.
   b. Center a section of potable water main pipe at least 17.5 feet long over sewer so that sewer joints are equidistant from potable water main joints.
   c. Provide adequate structural support where potable water main crosses under sewer. At minimum, provide compacted select backfill for ten feet on each side of crossing.
   d. Exceptions:
      1) Where it is not possible to provide minimum vertical separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe. Hydrostatically test water main and sewer as specified in this Section, prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.
      2) Encase either potable water main or sewer in watertight carrier pipe extending ten feet on each side of crossing, measured perpendicular to potable water main.

D. Plugs:
   1. Temporarily plug installed pipe at end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
   2. Install standard plugs in bells at dead ends, tees, and crosses. Cap spigot and plain ends.
   3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.
   4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to Engineer.

E. Bedding Pipe: Bed pipe as specified and in accordance with details on the Drawings.
   1. Trench excavation and backfill, and bedding materials shall conform to Section 02200, Earthwork, as applicable.
   2. Where pipe is installed in rock excavation, provide minimum of three inches of granular bedding material underneath pipe smaller than four-inch nominal diameter, and minimum of six inches of granular bedding material underneath pipes four-inch nominal diameter and larger.
   3. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.
   4. Carefully and thoroughly compact pipe bedding with hand held pneumatic compactors.
   5. Do not lay pipe until Engineer approves bedding condition.
   6. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.

F. Laying Pipe:
   1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
      a. Ductile Iron Pipe: ANSI/AWWA C600, ANSI/AWWA C105, AWWA M41.
      b. Concrete Pipe: AWWA M9.
      c. Sanitary and Storm Sewers: ASCE 37.
   2. Install pipe accurately to line and grade shown and indicated in the Contract Documents, unless otherwise approved by Engineer. Remove and reinstall pipes that are not installed correctly.
   3. Slope piping uniformly between elevations shown.

4. Keep groundwater level in trench at least 24 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by Engineer.
6. Place bell and spigot-type pipe so that bells face the direction of laying, unless otherwise approved by Engineer.
7. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom.
8. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by Engineer.
9. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation. Immediately remove defective materials from the Site and replace with acceptable products.
10. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell and spigot-type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.
11. Field cut pipe, where required, with machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with smooth end at right angles to axis of pipe. Cut ends on push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
12. Do not place blocking under pipe, unless specifically approved by Engineer for special conditions.
13. Touch up protective coatings in manner satisfactory to Engineer prior to backfilling.
14. Notify Engineer in advance of backfilling operations.
15. On steep slopes, take measures acceptable to Engineer to prevent movement of pipe during installation.
16. Thrust Restraint: Where required, provide thrust restraint conforming to Article 3.3 of this Section.
17. Exercise care to avoid flotation when installing pipe in cast-in-place concrete, and in locations with high groundwater.

G. Polyethylene Encasement:
1. Provide polyethylene encasement for ductile iron piping to prevent contact between pipe and surrounding bedding material and backfill.
2. Polyethylene encasement installation shall be in accordance with ANSI/AWWA C105.

H. Jointing Pipe:
1. Ductile Iron Mechanical Joint Pipe:
a. Immediately before making joint, wipe clean the socket, plain end, and adjacent areas. Taper cut ends and file off sharp edges to provide smooth surface.
b. Lubricate plain ends and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with ANSI/AWWA C111, just prior to slipping gasket onto plain end of the joint assembly.
c. Place gland on plain end with lip extension toward the plain end, followed by gasket with narrow edge of gasket toward plain end.
d. Insert plain end of pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
e. Push gland toward socket and center gland around pipe with gland lip against gasket.
f. Insert bolts and hand-tighten nuts.
g. If deflection is required, make deflection after joint assembly and prior to tightening bolts. Alternately tighten bolts approximately 180 degrees apart to seat gasket evenly. Bolt torque shall be as follows:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120

h. Bolts and nuts, except those of stainless steel, shall be coated with two coats, minimum dry film thickness of eight mils each, of high build solids epoxy or bituminous coating manufactured by Tnemec, or equal.

i. Restrained mechanical joints shall be in accordance with Section 15061, Ductile Iron Pipe.

2. Ductile Iron Push-On Joint Pipe:
   a. Prior to assembling joints, thoroughly clean with wire brush the last eight inches of exterior surface of spigot and interior surface of bell, except where joints are lined or coated with a protective lining or coating.
   b. Wipe clean rubber gaskets and flex gaskets until resilient. Conform to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.
   c. Insert gasket into joint recess and smooth out entire circumference of gasket to remove bulges and to prevent interference with proper entry of spigot of entering pipe.
   d. Immediately prior to joint assembly, apply thin film of pipe manufacturer's recommended lubricant to surface of gasket that will come in contact with entering spigot end of pipe, or apply a thin film of lubricant to outside of spigot of entering pipe.
   e. For assembly, center spigot in pipe bell and push pipe forward until spigot just makes contact with rubber gasket. After gasket is compressed and before pipe is pushed or pulled in the rest of the way, carefully check gasket for proper position around the full circumference of joint. Final assembly shall be made by forcing spigot end of entering pipe past gasket until spigot makes contact with base of the bell. When more than a reasonable amount of force is required to assemble the joint, remove spigot end of pipe to verify proper positioning of gasket. Do not use gaskets that have been scored or otherwise damaged.
   f. Maintain an adequate supply of gaskets and joint lubricant at the Site when pipe jointing operations are in progress.
3. Ductile Iron Proprietary Joints:
   a. Install pipe that utilizes proprietary joints for restraint specified in Section 15061, Ductile Iron Pipe, or other such joints, in accordance with manufacturer's instructions.
4. Copper Tubing Joints:
   a. Soldered Joints:
      1) Assemble copper tubing with soldered joints. Solder shall be 95-5 tin-antimony solder conforming to ASTM B32.
      2) Ream or file pipe to remove burrs.
      3) Clean and polish contact surfaces of joints.
      4) Apply flux to both male and female ends.
      5) Insert end of tube into full depth of fitting socket.
      6) Heat joint evenly.
      7) Form continuous solder bead around entire circumference of joint starting at the bottom.
5. Mechanical Coupling Joints:
   a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end couplings, plasticized

PVC couplings, and other mechanical couplings specified in Section 15120, Couplers, Adapters, and Specials for Piping.

b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with wire brush to remove foreign matter.

c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.

I. Backfilling:
1. Conform to applicable requirements of Section 02200, Earthwork.
2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

J. Connections to Valves and Hydrants:
1. Install valves and hydrants as shown and indicated in the Contract Documents.
2. Provide suitable adapters when valves or hydrants and piping have different joint types.
3. Provide thrust restraint at all hydrants and at valves located at pipeline terminations.

K. Transitions from One Type of Pipe to Another:
1. Provide necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

L. Closures:
1. Provide closure pieces shown or required to complete the Work.

3.2 TRACER TAPE INSTALLATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:
1. Provide polyethylene tracer tape for buried metallic piping, which includes pipe that is steel, ductile iron, cast iron, concrete, copper, and corrugated metal.
2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
4. Tape shall be spread flat with message side up before backfilling.

B. Polyethylene Underground Warning Tape for Non-Metallic Pipelines:
1. Provide polyethylene tracer tape for buried non-metallic piping, which includes pipe that is reinforced concrete pipe, .
2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
4. Tape shall be spread flat with message side up before backfilling.

3.3 THRUST RESTRAINT

A. Provide thrust restraint on pressure piping systems where shown or indicated in the Contract Documents.

B. Thrust restraint may be accomplished by using restrained pipe joints, concrete thrust blocks, or harnessing buried pipe. Thrust restraints shall be designed for axial thrust exerted by test pressure

specified in the Buried Piping Schedule at the end of this Section.

C. Place concrete thrust blocks against undisturbed soil. Where undisturbed soil does not exist, or for projects where the Site consists of backfill material, thrust restraint shall be provided by restrained pipe joints.

D. Restrained Pipe Joints:
   1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
      a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with proprietary restrained joint system as specified in Section 15061, Ductile Iron Pipe; lugs and tie rods; or other joint restraint systems approved by Engineer.
      b. Prestressed Concrete Cylinder Pipe Joints: Restrain utilizing clamp type restrained joint, snap ring-type restrained joint, or by welding. Restrain, at a minimum, pipe segments to all wall fittings, and both joints of all bends and other transition pieces. Concrete pipe requiring restraint shall have sufficient longitudinal steel reinforcement provided to handle thrust forces at maximum design stress of 12,500 psi. Thrust forces in longitudinales must be transmitted directly to steel joint bands using welded connections sufficient to carry stresses involved. No allowance for the concrete to handle tensile forces is allowed. Thrust restraint shall be in accordance with ANSI/AWWA Manual M9.
      c. Joints for Concrete Pipe Other than Prestressed Concrete Cylinder Pipe: Restrain joints utilizing clamp type restrained joint or snap ring-type restrained joint.

E. Concrete Thrust Blocks:
   1. Provide concrete thrust blocks on pressure piping at changes in alignment of 15 degrees or more, at tees, plugs and caps, and where shown or indicated in the Contract Documents. Construct thrust blocks of Class B concrete, conforming to Section 03300, Cast-In-Place Concrete.
   2. Install thrust blocks against undisturbed soil. Place concrete so that pipe and fitting joints are accessible for repair.
   3. Concrete thrust block size shall be as shown on the Drawings or as approved by Engineer.

F. Harnessed lengths of buried pipe shall be determined by the pipe manufacturer in accordance with the formula for determination of buried pipe harnessed lengths located at the end of this Section.

3.4 WORK AFFECTING EXISTING PIPING

A. Location of Existing Underground Facilities:
   1. Locations of existing Underground Facilities shown on the Drawings should be considered approximate.
   2. Determine the true location of existing Underground Facilities to which connections are to be made, crossed, and that could be disturbed, and determine location of Underground Facilities that could be disturbed during excavation and backfilling operations, or that may be affected by the Work.

B. Work on Existing Pipelines or Underground Facilities:
   1. Cut or tap piping or Underground Facilities as shown or required with machines specifically designed for cutting or tapping pipelines or Underground Facilities, as applicable.
   2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
   3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.

3.5 FIELD QUALITY CONTROL

A. General:
   1. Test all piping, except as exempted in the Buried Piping Schedule in this Section.
   2. When authorities having jurisdiction are to witness tests, notify Engineer and authorities having jurisdiction in writing at least 48 hours in advance of testing.
   3. Conduct all tests in presence of Engineer.
   4. Remove or protect pipeline-mounted devices that could be damaged by testing.
   5. Provide all apparatus and services required for testing, including:
      a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain Owner's operations.
      b. Temporary bulkheads, bracing, blocking, and thrust restraints.
   6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
   7. Unless otherwise specified, Owner will provide fluid required for hydrostatic testing. Contractor shall provide means to convey fluid for hydrostatic testing into piping being tested. Contractor shall provide fluid for other types of testing required.
   8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
   9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by Contractor and that fails the test shall be repaired upon authorization of Owner. Unless otherwise included in the Work, repair of existing piping or Underground Facilities will be paid as extra Work.

B. Test Schedule:
   1. Refer to the Buried Piping Schedule in this Section for type of test required and required test pressure.
   2. Unless otherwise specified, required test pressures are at lowest elevation of pipeline segment being tested.
   3. For piping not listed in Buried Piping Schedule in this Section:
      a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires separate test.
      b. Use exfiltration testing, low-pressure air testing, or vacuum testing for other piping.
      c. Disinfect for bacteriological testing piping that conveys potable water.
   4. Test Pressure:
      a. Use test pressures listed in Buried Piping Schedule in this Section.
      b. If test pressure is not listed in Buried Piping Schedule, or if test is required for piping not listed in the Buried Piping Schedule, test pressure will be determined by Engineer based on maximum anticipated sustained operating pressure and methods described in applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:
   1. Preparation for Testing:
      a. Follow procedures described in ANSI/AWWA Manual M9. Wetting period is not required for pipe that is not cement mortar-lined.
      b. Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
   2. Test Procedure:
      a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
      b. Expel air from pipe as required. Obtain approval of Engineer prior to tapping pipe for expelling air.

c. Examine exposed joints and valves, and make repairs to eliminate visible leakage.
d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
e. Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
f. Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure.
g. Pump from test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at 15 minute intervals for duration of test.

3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of test pressure during timed test period. Allowable leakage rates for piping are:
   a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
   b. Rates based on formula or table in ANSI/AWWA Manual M41:
      1) Metal pipe joined with rubber gaskets as sealing members, including the following joint types:
         a) Bell and spigot and push-on joints.
         b) Mechanical joints.
         c) Bolted sleeve type couplings.
         d) Grooved and shouldered couplings.
   c. Rates based on make-up allowance in ANSI/AWWA Manual M9:
      1) Prestressed concrete cylinder pipe and other types of concrete pipe joined with O-ring rubber gasket sealing members.

D. Sanitary Sewer and Storm Drain Testing:
1. Contractor may test sanitary sewer and storm drain piping using the method specified in one of the following: Paragraph 2 or 3. Notify Engineer in writing in advance of the first test of method to be used for testing, and use the same test method for testing all sanitary sewer and storm drain piping in the Contract, unless otherwise accepted by Engineer.
2. Exfiltration Testing:
   a. Plug and bulkhead ends and lateral connections of pipe segment to be tested and admit fluid until the pipe is full. Admit fluid slowly to minimize air entrapment. Groundwater level shall be below the pipe during exfiltration test.
   b. Before measuring leakage, allow fluid to wet pipe interior for the following period:
      1) Concrete Pipe: 48 hours.
      2) Cement Mortar-lined Pipe: 24 hours.
      3) Other Pipe: Wetting period not required.
   c. Provide minimum hydrostatic head during test of two feet above crown of upstream end of pipe segment tested.
   d. Add fluid from test container or from metered supply as required to maintain test water level within three inches of test head throughout the test.
   e. Test duration shall be at least two hours.
   f. Allowable Leakage Rates:
      1) Leakage is defined as the quantity of fluid that must be supplied to pipe segment tested to maintain hydrostatic head within three inches of test head during the test after pipe has been filled and exposed to required wetting period, plus quantity required to refill to original head at end of test.
      2) Leakage shall not exceed the following rates:
         a) Gravity Sewer: 0.079 gallons per hour per 100 feet of pipe per inch in diameter in pipe.
         b) Storm Drains: 0.79 gallons per hour per 100 feet of pipe per inch diameter of pipe.

3. Low Pressure Air:
    a. Plug and bulkhead ends and lateral connections of pipe segment to be tested.
    b. Required test pressure shall be increased by an amount equal to the elevation of groundwater above invert of lowest point of pipe segment being tested.
    c. Test in accordance with requirements of authority having jurisdiction.
    d. If there are no Laws and Regulations covering the test, use test procedures described in the following standards:
        1) Concrete Pipe: ASTM C924.

E. Bacteriological Testing:
    1. Bacteriological testing for potable water lines, finished water lines, and other piping in accordance with the Buried Piping Schedule, is specified in Article 3.6 of this Section.

3.6 CLEANING AND DISINFECTION

A. Cleaning, General: Clean pipe systems as follows:
    1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in manner approved by Engineer, prior to placing in service.
    2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed.
    3. For piping that requires disinfection and has not been kept clean during storage or installation, swab each section individually before installation with five percent sodium hypochlorite solution.

B. Disinfection:
    1. Disinfect all potable and finished water piping.
    2. Suggested procedure for accomplishing complete and satisfactory disinfection is specified below. Other procedures may be considered for acceptance by Engineer.
        a. Prior to disinfection, clean piping as specified and flush thoroughly.
        b. Conform to procedures described in ANSI/AWWA C651. Use continuous feed method of disinfecting, unless alternative method is acceptable to Engineer.
    3. Water for initial flushing, testing, and disinfection will be furnished by Owner. Contractor shall provide all temporary piping, hose, valves, appurtenances, and services required. Cost of water required for redisinfection will be paid by Contractor to Owner at water utility's standard rates.
    4. Chlorine shall be provided by Contractor.
    5. Bacteriologic tests will be performed by Owner. Certified test laboratory report will be provided to Contractor, if requested.
    6. Chlorine concentration in water entering the piping shall be between 50 and 100 ppm, such that minimum residual concentration of 25 mg/L remains after 24-hour retention period. Disinfect piping and all related components. Repeat as necessary to provide complete disinfection.
    7. After required retention period, flush chlorinated water to closed drain line, unless otherwise acceptable to Engineer. Properly dispose of chlorinated water in accordance with Laws and Regulations. Do not discharge chlorinated water to storm sewers, ditches, or overland.

3.7 BURIED PIPE HARNESS FORMULA

FORMULA FOR DETERMINATION
OF BURIED PIPE
HARNESSED LENGTHS

Lengths shall be based on the following formula:

$$L = \frac{T}{f \cdot \sum W}$$

$$T = 1.25 \cdot P \cdot A \cdot \sin\frac{\Delta}{2}$$

where: T = Thrust (lbs.)
P = Test pressure (psi)
A = Pipe area (sq. in.)
Δ = Angle of bend.
f = Friction factor between soil and pipe = 0.3*.
$\Sigma W = W_p + W_s + W_w$.
W_p = Weight of pipe (lbs. per linear foot).
W_s = Weight of soil (lbs. per linear foot)**.
W_w = Weight of fluid (lbs. per linear foot).

* For ductile iron and steel pipe, the friction factor f = 0.1.
** Based on depth of cover on pipe, and outside diameter of pipe. Soil weight equals 100 lbs./ft^3.

3.8 SCHEDULES

A. Schedules listed below, following the "End of Section" designation, are part of this Specification section.
1. Table 15051-A, Buried Piping Schedule.

TABLE 15051-A, BURIED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test (psig)	Remarks
DR	≤24	RCP	-	-	Class V	BS	EX	Storm Drain
EW	6	DI	CL	AC/PEW	Class 53	RMJ	HYD 50	If existing material is not DI, replace in kind
FTE	16	DI	CL	AC/PEW	Class 53	RMJ	HYD 50	
FPW	6	DI			Class 53	RMJ	HYD 50	
TD	24	DI	CL	AC/PEW	Class 53	MJ	EX	Aeration Tank Drain
SCE	6	DI	CL	AC/PEW	Class 53	RMJ	HYD 50	Service Water
CW	1-1/2	C			Type K	Sd	HYD 50, DBT	Water Service
SA	2	SS			Schedule 10	SW	HYD	Service Air

The following abbreviations are used in the Buried Piping Schedule:

A. Service Abbreviations:

Service:	Abbrev.:		Service:	Abbrev.:
Drain	DR		City Water	CW
Screened Effluent Water	SCE		Service Air	SA
Biofilter Recirculation Loop	Recirc			
Fire Protection Water	FPW			
Effluent Water	EW			

B. Material Abbreviations:

Material	Abbrev.
Ductile Iron	DI
Stainless Steel	SS
Copper	C
Reinforced Concrete Pipe	RCP

C. Lining/Coating Abbreviations:

Lining	Abbrev.
Cement Mortar Lined	CL
Asphaltic Coated	AC
Polyethylene Wrapped	PEW

D. Joint Abbreviations:

Joint Type	Abbrev.
Bell and Spigot	BS
Restrained Push-on Joint	RPOJ
Mechanical Joint	MJ
Soldered	Sd
Solvent Weld	SW

E. Test Abbreviations:

Test	Abbrev.
Hydrostatic Test (test pressure in psig)	HYD ( )
Exfiltration	EX
Disinfection and Bacteriological Testing	DBT

+ + END OF SECTION + +

SECTION 15060

HANGERS AND SUPPORTS FOR HVAC DUCTWORK, PIPING, AND EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install hangers and supports complete with required appurtenances for HVAC ductwork, piping, and equipment.
   2. Coordination:
      a. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the hangers and supports for HVAC ductwork, piping, and equipment Work.
   3. Related Sections:
      a. Section 03600, Grouting.
      b. Section 05051, Anchor Systems.
      c. Section 05120, Structural Steel Framing.
      d. Section 05500, Miscellaneous Metal Fabrications.

1.02 REFERENCES

1. Standards referenced in this Section are:
   a. ANSI B1.1 – Unified Inch Screw Threads (ASME B1.1).
   b. ASCE 7 – Minimum Design Loads for Buildings and Other Structures.
   c. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.
   d. ASTM A47/A47M – Standard Specification for Ferritic Malleable Iron Castings.
   e. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   f. ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   g. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   h. ASTM A575 – Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
   i. ASTM A668/A688M – Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
   j. AWS B2.1 – Specification for Welding Procedure and Performance Qualification.
   k. FS WW-H-171 – Hangers and Supports, Pipe.
   l. MSS SP 58 – Pipe Hangers and Supports-Materials, Design and Manufacture.
   m. MSS SP 69 – Pipe Hangers and Supports - Selection and Application.

n. HVAC Duct Construction Standards – Metal and Flexible.

1.03 QUALITY ASSURANCE

1. Qualifications:
   a. Manufacturer:
      1) Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years in the continental United States.
      2) Equipment shall be manufactured in the United States.
   b. Professional Engineer:
      1) Engage a registered professional engineer legally qualified to practice in the jurisdiction where the Project is located and experienced in providing engineering services of the kind indicated.
      2) Submit qualifications data.
      3) Responsibilities include but are not necessarily limited to:
         (a) Carefully reviewing system performance and design criteria stated in the Contract Documents.
         (b) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
         (c) Preparing or supervising the preparation of design calculations and related drawings, Shop Drawings, testing plan development, test-result interpretation and a comprehensive engineering analysis verifying compliance of the system with the requirements of the Contract Documents.
         (d) Signing and sealing all calculations and design drawings, and Shop Drawings.
         (e) Certifying that:
            (1) It has performed the design of the system in accordance with the performance and design criteria stated in the Contract Documents, and
            (2) The said design conforms to all applicable local, state and federal codes, rules and regulations, and to the prevailing standards of practice.
   c. Installer:
      1) Engage an experienced installer to perform the work of this Section who has specialized in installing hangers and supports for HVAC ductwork, piping, and equipment similar to that required for this Project and who is acceptable to manufacturer.
      2) Submit name and qualifications to Engineer along with the following information on a minimum of three successful projects:
         (a) Names and telephone numbers of owners, architects or engineers responsible for projects.
         (b) Approximate contract cost of the hangers and supports for HVAC ductwork, piping, and equipment.

(c) Amount of area installed.

d. Welding:
   1) Qualify processes and operators in accordance with AWS B2.1 as appropriate for material to be welded.
   2) Provide certification that operators employed on or to be employed for the Work have satisfactorily passed AWS qualifica-tion tests within previous 12 months. Ensure that all certifications are current.

2. Component Supply and Compatibility:
   a. Obtain all equipment included in this Section regardless of the component manufacturer from a single hangers and supports for HVAC ductwork, piping, and equipment manufacturer.
   b. Require the hangers and supports for HVAC ductwork, piping, and equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   c. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the hangers and supports for HVAC ductwork, piping, and equipment manufacturer.
3. Regulatory Requirements:
   a. International Building Code (IBC).
   b. National Fire Protection Association (NFPA).
   c. Local and State Building Codes and Ordinances.
   d. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

1.04 SUBMITTALS

1. Action Submittals: Submit the following:
   a. Shop Drawings:
      1) Drawings showing fabrication methods, assembly, accessories, and installation details.
      2) Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
      3) Drawings showing floor supported components and installation arrangement.
   b. Product Data:
      1) Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
      2) Complete component list.
      3) Detailed description of each component.
      4) Catalog cut sheets for each component.
      5) Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
      6) Other technical data related to specified material and equipment as requested by Engineer.

c. Delegated Design Submittals:
    1) 1/4-inch scale HVAC ductwork, piping, and equipment layouts, dimensioned to show length of runs, with all expansion joints, alignment guides, anchors and appurtenances required for proper control of HVAC ductwork, piping, and equipment forces. The drawings shall include all forces acting on the HVAC ductwork, piping, and equipment and the corresponding reactions of the compensation and anchor devices provided.
    2) All drawings, design calculations, and a letter indicating that the hanger and support systems have been properly designed shall be signed and sealed by a registered professional engineer legally qualified to practice in the jurisdiction where the Project is located.

2. Informational Submittals: Submit the following:
    a. Certificates:
        1) Independent certification reports.
    b. Manufacturer Instructions:
        1) Instructions and recommendations for handling, storing, protecting the equipment.
        2) Installation Data.
    c. Source Quality Control Submittals:
        1) Factory test reports.
    d. Qualifications Statements:
        1) Manufacturer
        2) Professional Engineer
        3) Installer
        4) Welding

PART 2 PRODUCTS

2.01 SYSTEM PERFORMANCE

A. Design Criteria:
    1. Designs generally accepted as exemplifying good engineering practice and using stock or production parts shall be utilized wherever possible.
    2. Accurate weight balance calculations shall be made to determine the required force at each hanger and support location and the weight load at each force concentration point.
    3. Hangers and supports shall be capable of supporting and restraining HVAC ductwork, piping, and equipment in all conditions of operation. They shall allow free expansion and contraction, and prevent excessive stress resulting from transferred weight being induced into the HVAC ductwork, piping, and equipment.
    4. Hangers and supports shall be designed so that they cannot become disengaged by movements of the supported HVAC ductwork, piping, and equipment.
    5. Rod length shall be limited to a maximum length of eight linear feet.
    6. HVAC ductwork, piping, and equipment that cannot be hung by rod and hanger arrangement shall be floor or wall supported.

7. All structural components shall be designed based on static and dynamic loads imposed by the supported HVAC ductwork, piping, and equipment and shall include a safety factor of 2 for the yield strength. Minimum angle sizes shall be 2-inch x 2-inch x1/4-inch.
8. Load ratings, materials and installation shall be consistent with the recommendations from the latest edition of MSS SP 58, MSS SP 69, and FS WW-H-171.
9. Hanger and support design calculations for all HVAC ductwork, piping, and equipment shall be signed and sealed by a registered professional engineer legally qualified to practice in the jurisdiction where the Project is located.

2.02 MANUFACTURERS

1. Manufacturer: Provide product of one of the following:
   a. Erico International Corporation.
   b. Anvil International.
   c. Or equal.

2.03 DETAILS OF CONSTRUCTION

1. Materials:
   a. Hangers, supports, restraints, and appurtenances shall be hot dipped galvanized steel in accordance with ASTM A123/A123M and ASTM A153/A153M.
   b. Hangers, supports, restraints, and appurtenances located outdoors shall be Type 316 stainless steel.
   c. Steel used for the support of uninsulated copper piping or plastic piping shall be PVC coated.
2. Components of hangers and supports shall conform to the following:
   a. Bolts: ASTM A307, Grade A, unless otherwise specified below.
   b. Forgings: ASTM A668/A688M.
   c. Malleable Iron: ASTM A47/A47M.
   d. Rods and Bars: ASTM A575.
   e. Threads: Unified Screw Threads, Class 2A and 2B, ANSI B1.1.
   f. Structural Steel: ASTM A36/A36M.
3. Hanger Attachments: The following types of attachments shall be considered acceptable:
   a. Adjustable Steel Clevis: FS WW-H-171E, Type 1.
   b. Steel Double Bolt Pipe Clamp: FS WW-H-171E, Type 3.
   c. Steel Pipe Clamp: FS WW-H-171E, Type 4.
   d. Adjustable Swivel Pipe Ring: FS WW-H-171E, Type 6.
   e. Adjustable Steel Band Hanger: FS WW-H-171E, Type 7.
   f. Riser Clamp: FS WW-H-171E, Type 8.
   g. Light-Duty Clevis Hanger: FS WW-H-171E, Type 12.
   h. Long Clips: FS WW-H-171E, Type 26.
   i. Offset J-Hooks: FS WW-H-171E, Type 27.
   j. Steel Pipe Covering Protection Saddle: FS WW-H-171E, Type 40A.
   k. Insulation Protection Shield: FS WW-H-171E, Type 41.
   l. Pipe Saddle Support: FS WW-H-171E, Type 37.

m. Pipe Stanchion Saddle: FS WW-H-171E, Type 38.
n. Pipe Saddle Support with Base: FS WW-H-171E, Type 36.
o. Adjustable Roller Hanger: FS WW-H-171E, Type 42.

4. Structural Attachments: The following types of attachments shall be considered acceptable:
   a. Side Beam Clamp: FS WW-H-171E, Type 20.
   b. Center I-Beam Clamp: FS WW-H-171E, Type 21.
   c. Welded Steel Bracket: FS WW-H-171E, Types 32 and 33.
   d. Side Beam Bracket: FS WW-H-171E, Type 35.
5. Hanger Rod Attachments: Use as required to complete assembly:
   a. Forged Steel Clevis: FS WW-H-171E, Type 14.
   b. Adjustable Turnbuckle: FS WW-H-171E, Type 15.
   c. Forged Steel Welders Eye Nut: FS WW-H-171E, Type 17.
6. Concrete anchorage shall be provided in accordance with Section 05051, Anchor Systems.
7. Structural steel shall be provided in accordance with Section 05120, Structural Steel Framing.
8. Miscellaneous metal fabrications shall be provided in accordance with Section 05501, Miscellaneous Metal Fabrications.

2.04 SOURCE QUALITY CONTROL

1. Shop Tests:
   a. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
      1) Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
      2) Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that the package meets the specified performance requirements including manufacturer's data report.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

C. PREPARATION
   1. Surface Preparation:
      a. Attachment to hollow core slabs or double tee slabs shall be provided in accordance with details shown on the structural drawings to prevent damage to pre-stressing strands.

3.02 INSTALLATION

1. General:
   a. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   b. Install in accordance with Laws and Regulations.
   c. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
   d. Installation to conform to requirements of all local and state codes.
2. Ductwork:
   a. The construction and installation of hangers and supports for ductwork shall conform to the recommendations given in the latest SMACNA HVAC Duct Construction Standards except as specified.
   b. Hanger rods shall have threaded ends.
   c. All ductwork shall be supported from trapeze type hangers. No sheet metal duct hangers or straps will be allowed.
   d. A pair of rods shall be provided at each duct support point.
3. Piping:
   a. Insulated pipes with vapor barriers shall have an insulation protection shield conforming to FS WW-H-171E, Type 41 tack-welded to hanger.
   b. Insulated pipes without vapor barriers shall have a steel protection saddle conforming to FS WW-H-171E, Type 40A.
   c. All uninsulated copper piping shall be supported by plastic coated steel pipe attachments.
   d. All piping shall be braced as required, to prevent sway in any direction.
   e. All insulated piping 3-inch diameter and larger shall be supported by roller hangers with saddles conforming to FS WW-H-171E, Type 42.
   f. Additional supports shall be placed immediately adjacent to any change in direction.
   g. Supports for Vertical Piping:
      1) Provide riser clamp placed under hub, fitting or coupling with approved solid bearing on steel sleeve at each floor level.
      2) Where riser clamps are used with plastic piping they shall be modified so as not to exert any compressive forces on the pipe.
      3) Support spacing shall not exceed code requirements.
   h. Allow clearances for expansion and contraction of piping.
4. Anchorages and Base Plates:
   a. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents. Install anchors in accordance with Section 05051, Anchor Systems.
   b. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted shall then be accurately shimmed to grade and spaces between filled with non-shrink grout

in accordance with Section 03600, Grouting. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2 inch.

3.03 ADJUSTING

1. Adjust all equipment for proper settings.

3.04 SCHEDULES

1. Hangers and Supports for Ductwork:
   a. Spacing:
      1) Ductwork shall be supported at distances not exceeding the spacing specified below:
         (a) Metal Ductwork:
            (1) Maximum Spacing: 10 feet.
   b. Hanger Rod Sizes:
      1) Hanger rods shall be sized based on static and dynamic loads imposed by the supported ductwork and shall include a safety factor of 2 for the yield strength.
      2) Rod load shall not exceed rod manufacturer's recommended capacity.
2. Hangers and Supports for Piping:
   a. Spacing:
      1) Piping shall be supported at distances not exceeding the spacing specified below or in accordance with MSS SP 69:
         (a) Copper Tube:
            (1) Maximum Horizontal Spacing: 6 feet.
            (2) Maximum Vertical Spacing: 10 feet.
         (b) Copper Pipe:
            (1) Maximum Horizontal Spacing: 12 feet.
            (2) Maximum Vertical Spacing: 10 feet.
         (c) Steel Pipe:
            (1) Maximum Horizontal Spacing: 12 feet.
            (2) Maximum Vertical Spacing: 15 feet.
         (d) PVC Pipe:
            (1) Maximum Horizontal Spacing: 4 feet.
            (2) Maximum Vertical Spacing: 6 feet.
   b. Hanger Rod Sizes:
      1) Hanger rods shall be sized based on static and dynamic loads imposed by the supported piping and shall include a safety factor of 2 for the yield strength.
      2) Rod load shall not exceed rod manufacturer's recommended capacity.
3. Hangers and Supports for HVAC Equipment:
   a. Provide spacing and hanger rod sizes in accordance with equipment manufacturer's installation instructions.

+ + END OF SECTION + +

SECTION 15061

DUCTILE IRON PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish ductile iron pipe and fittings.
   2. Extent of piping is shown on the Drawings. Piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation, specify pipe service, diameter, material, lining, coating, pressure rating, joint type, and testing required.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ductile iron pipe Work.

C. Related Sections:
   1. Section 02200, Earthwork.
   2. Section 09900, Painting.
   3. Section 15051, Buried Piping Installation.
   4. Section 15052, Exposed Piping Installation.
   5. Section 15120, Couplers, Adapters, and Specials for Piping.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B18.2.1, Square and Hex Bolts and Screws Inch Series.
   2. ANSI B18.2.2, Square and Hex Nuts. (Inch Series).
   3. ASTM A193, Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   4. ASTM A194, Specification for Carbon Steel and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
   5. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   6. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   7. ASTM B117, Practice for Operating Salt Spray (Fog) Apparatus.
   8. ASTM C283, Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid.
   9. ASTM D714, Test Method for Evaluating Degree of Blistering of Paints.
   10. ASTM D792, Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   11. ASTM D2000, Standard Classification System for Rubber Products in Automotive Applications.
   12. ASTM D5162, Discontinuity (Holiday) Testing of Non-Conductive Protective Coating on Metallic Substrates.
   13. ASTM E96, Test Methods for Water Vapor Transmission of Materials.
   14. ASTM G14, Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).
   15. ASTM G95, Test Methods for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method).
   16. ANSI/AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
   17. ANSI/AWWA C110, Ductile Iron and Gray Iron Fittings for Water.
   18. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

19. ANSI/AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
20. ANSI/AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings for Water Service.
21. ANSI/AWWA C151, Ductile Iron Pipe, Centrifugally Cast, for Water.
22. ANSI/AWWA C153, Ductile Iron Compact Fittings, 3 inch through 24 inch and 54 inch through 64 inch for Water Service.
23. ANSI/AWWA C606, Grooved and Shouldered Type Joints.
24. MSS-SP 60, Connecting Flange Joint Between Tapping Sleeves and Tapping Valves.
25. NACE RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
26. NAPF 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
27. NSF/ANSI 61, Drinking Water System Components - Health Effects.
28. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
29. SSPC Painting Manual, Volume 1, Para. XIV.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have a minimum of five years successful experience producing ductile iron pipe and fittings and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
      b. Lining and coating products shall be manufactured by a firm with a minimum of five years successful experience in protecting pipelines exposed to the specified service conditions , and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
      c. When not applied by the manufacturer, lining and coating Subcontractor shall have a minimum of five years successful experience in the application of the specified linings and coatings for similar applications for the specified service, and shall be able to show evidence of at least five installations in satisfactory operation in the United States.

B. Supply and Compatibility:
   1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single ductile iron pipe manufacturer.
   2. Ductile iron pipe manufacturer shall review and approve or prepare all Shop Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.
   3. Pipe, fittings, and appurtenances shall be suitable for the specified service and shall be integrated into overall piping system by ductile iron pipe manufacturer.
   4. Ductile iron pipe manufacturer shall be responsible for all products and all factory-applied linings and coatings, whether installed at pipe manufacturer's facility or at manufacturer's Supplier's facility.

C. Regulatory Requirements:
   1. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF/ANSI 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following with Shop Drawings required under Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation:
   1. Shop Drawings:
      a. Detailed drawings and data for pipe, fittings, gaskets, appurtenances, linings, and coatings.
   2. Product Data:
      a. Surface preparation and application reports and procedures as required for lining and coating of pipe and fittings. Ductile iron pipe and fitting manufacturer and manufacturer and applicator of lining and coating, as specified, shall mutually determine recommended surface preparation and application methods, and provide written verification of mutually selected method in the submittals.
   3. Samples:
      a. Submit Sample of pipe and fitting with each type of lining, for use at the Site to verify continuity, surface gloss, and color, as applicable, via visual inspection.
   4. Test Procedures: For linings and coatings in pipe and fittings.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Submit certificate signed by manufacturer of each product that product conforms to applicable referenced standards and the Contract Documents.
      b. Submit certificate signed by applicator of the linings and coatings stating that product to be applied conforms to applicable referenced standards and that the applicator shall conform to the Contract Documents.
   2. Source Quality Control Submittals:
      a. Submit results of specified shop tests for pipe, fittings, linings, and coatings.
      b. Lining and coating test coupons.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General:
   1. Piping systems shall be suitable for their intended use.
   2. Joints shall be as specified in Section 15051, Buried Piping Installation and Section 15052, Exposed Piping Installation. If not specified, provide flanged joints for exposed piping and push-on or mechanical joints for buried piping. Provide couplings on pipe with plain or grooved ends where shown or where approved by Engineer.

B. Ductile Iron Pipe, Joints, and Fittings:
   1. Flanged Pipe: Fabricate in accordance with ANSI/AWWA C115.
      a. Pressure Rating: As specified in piping schedule in Section 15052, Exposed Pipe Installation. If not otherwise specified, use Special Thickness Class 53 .
   2. Non-Flanged Pipe: Conform to ANSI/AWWA C151 for material, pressure, dimensions, tolerances, tests, markings, and other requirements.
      a. Pressure Class: As specified in piping schedules in Section 15051, Buried Piping Installation and Section 15052, Exposed Piping Installation.
      b. Special Thickness Class: As specified in piping schedules in Section 15051, Buried

Piping Installation and Section 15052, Exposed Piping Installation.

3. Pipe Joints:
   a. Flanged Joints: Conform to ANSI/AWWA C110 and ANSI/AWWA C111 capable of meeting the pressure rating or special thickness class, and test pressure specified in piping schedule in Section 15052, Exposed Pipe Installation.
      1) Gaskets: Unless otherwise specified, gaskets shall be at least 1/8-inch thick, ring or full-face as required for the pipe, of synthetic rubber compound containing not less than 50 percent by volume nitrile or neoprene, and shall be free from factice, reclaimed rubber, and other deleterious substances. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe and fittings.
      2) Bolts: Comply with ANSI B18.2.1.
         a) Exposed: ASTM A307, Grade B.
         b) Buried or Submerged: ASTM A193, Grade B8M, Class 2, Heavy hex, Type 316 stainless steel.
      3) Nuts: Comply with ANSI B18.2.2.
         a) Exposed: ASTM A563, Grade A, Heavy hex.
         b) Buried or Submerged: ASTM A194, Grade B8M, Heavy hex, Type 316 stainless steel.
   b. Mechanical Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure rating or special thickness class, and test pressure specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
      1) Glands: Ductile iron.
      2) Gaskets: Plain tip.
      3) Bolts and Nuts: High strength, low alloy steel.
      4) Manufacturers: Provide products of one of the following:
         a) Clow Water Systems Company
         b) Atlantic States Cast Iron Pipe Company
         c) McWane Cast Iron Pipe Company
         d) Griffin Pipe Products Co.
         e) U.S. Pipe and Foundry Co.
         f) Or equal.
   c. Push-On Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure class or special thickness class, and test pressure specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
      1) Gaskets: Vulcanized SBR, unless otherwise specified.
      2) Stripes: Each plain end shall be painted with a circular stripe to provide a guide for visual check that joint is properly assembled.
      3) Products and Manufacturers: Provide one of the following:
         a) Tyton or Fastite Joint by Clow Water Systems, Atlantic States Cast Iron Pipe Company, Canada Pipe Company, Ltd., McWane Cast Iron Pipe Company, Pacific States Cast Iron Pipe Company, and Griffin Pipe Products Company.
         b) Fastite Joint by American Cast Iron Pipe Company.
         c) Tyton Joint by U.S. Pipe and Foundry Company.
         d) Or equal.
   d. Grooved End Joints: Comply with ANSI/AWWA C606.
      1) Gaskets: Flush seal type designed for ductile iron that complies with or exceeds requirements of ASTM D2000
      2) Bolts and nuts: As specified for flanged joints.
      3) Unless otherwise specified, grooved end couplings shall be rigid joint for exposed service and flexible joint for buried service.
      4) Products and Manufacturers: Provide one of the following:
         a) Victaulic, Style 31.

b) Tyler Pipe, Gustin Bacon Division, Series 500.
c) Or equal.

e. Restrained Joints: Restrained push-on joints shall be capable of being deflected after full assembly. Field cuts of restrained pipe are not allowed without approval of Engineer.
1) Products and Manufacturers: Provide restrained joints for mechanical joint piping by one of the following:
a) Megalug, Series 1100, by EBBA Iron Sales, Inc.
b) Uni-Flange, Series 1400, by Ford Meter Box Co.
c) One-Lok, Series SLD, by SIGMA Corporation.
d) Stargrip, Series 3000, by Star Pipe Products.
e) Or equal.
2) Products and Manufacturers: Provide restrained joints for push-on joint piping by one of the following:
a) Super-Lock Joint Pipe, by Clow Water Systems, a division of McWane, Inc.
b) TR Flex Joint, by U.S. Pipe and Foundry Company.
c) Snap-Lok, by Griffin Pipe Products Company.
d) Megalug, Series 1700, by EBBA Iron Sales, Inc.
e) Uni-Flange, Series 1450, by Ford Meter Box Co.
f) One-Lok, Series SSLDH, by SIGMA Corporation.
g) Stargrip, Series 3100P, by Star Pipe Products.
h) Or equal.

4. Flanged and Push-On Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
a. Material: Ductile iron.
b. Pressure rating, gaskets, bolts, and nuts shall be as specified for flanged joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of the connected pipe.

5. Mechanical Joint Fittings: Comply with ANSI/AWWA C153, ANSI/AWWA C110 and ANSI/AWWA C111.
a. Material: Ductile iron.
b. Glands: Ductile iron.
c. Pressure rating, gaskets, bolts, and nuts shall be as specified for mechanical joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of connected pipe.

C. Lining, General:
1. Surface Preparation:
a. Initial Surface Inspection: Surface to be lined shall be inspected by pipe and fitting manufacturer and applicator, if applicator is other than pipe and fitting manufacturer. Inspecting parties shall inspect surface to be coated and mutually determine recommended surface preparation method.
b. Surface Preparation: Prepare surface in accordance with recommended method.
c. Finished Surface Inspection: Lining applicator shall inspect finished surface prior to application to determine acceptability. If surface is unacceptable, repeat surface preparation as necessary.

D. Cement-mortar Lining:
1. Where specified in piping schedules included with Section 15051, Buried Piping Installation and Section 15052, Exposed Piping Installation, pipe and fittings shall be lined with bituminous seal coated cement-mortar lining in accordance with ANSI/AWWA C104.

E. Couplings:
1. Refer to Section 15120, Couplings, Adapters, and Specials for Process Piping.

F. Specials:
   1. Transition Pieces:
      a. Provide suitable transition pieces (adapters) for connecting to existing piping.
      b. Unless otherwise shown or indicated, expose existing piping to determine material, dimensions, and other data required for transition pieces.
   2. Taps:
      a. Provide taps where shown or required for small-diameter piping or instrumentation connections.
      b. Provide corporation stops where shown or required.
      c. Where pipe wall thickness or tap diameter will not allow engagement of 5 full threads, provide tapping saddle with outlet joints conforming to requirements of Paragraph 2.1.B.3.a of this Section for four-inch through 12-inch diameter pipe, and Paragraph 2.1.B.3.b. for 14-inch through 54-inch diameter pipe.
      d. For flanged connections on tapping saddle outlet branch, counterbore flange in accordance with MSS SP-60 dimensions. Inside diameter of outlet shall be 1/4-inch greater than nominal diameter.
   3. Tangential Outlets:
      a. Provide tangential outlet fittings where shown or indicated.
      b. Weld-on fittings are acceptable.
      c. Flanged and grooved end joints are not allowed.

2.2 MARKING FOR IDENTIFICATION

A. In addition to identification markings specified in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation, also stamp, mark, and identify push-on joint and mechanical joint pipe with:
   1. Name or trademark of manufacturer.
   2. Weight, class or nominal thickness, and casting period.
   3. Country where cast.
   4. Year the pipe was produced.
   5. Letters “DI” or “Ductile” shall be cast or metal stamped

B. In addition to identification markings specified in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation, also stamp, mark, and identify flanged pipe with:
   1. Flange manufacturer’s mark, size, and letters “DI” cast or stamped on the flanges.
   2. Fabricator’s mark if other than flange manufacturer.
   3. Length and weight.

C. In addition to identification markings specified in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation, also stamp, mark, and identify fittings with:
   1. Manufacturer’s identification.
   2. Pressure rating.
   3. Nominal diameters of openings.
   4. Country where cast.
   5. Number of degrees or fraction of the circle on bends.
   6. Letters “DI” or “Ductile” cast on them.

2.3 EXTERIOR SURFACE PREPARATION AND COATINGS

A. General Coating Requirements:
   1. Coating types are specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. Exposed Pipe and Fittings:
   1. Surface Preparation:

a. Initial Surface Inspection: Pipe and fitting manufacturer and coating applicator shall inspect surface to be coated and mutually determine recommended NAPF 500-03 surface preparation method.
b. Surface Preparation: Prepare surface in accordance with recommended NAPF 500-03 method.
c. Finished Surface Inspection: Prepared surfaces shall be inspected by coating applicator prior to application to determine acceptability of finished surface. If surface is unacceptable, repeat surface preparation and re-application as necessary.

2. After recommended surface preparation, prime coat exterior ferrous metal surfaces of pipe and fittings in the shop in accordance with Section 09900, Painting.
3. Field painting shall comply with Section 09900, Painting.

C. Buried Pipe and Fittings:
1. Asphaltic Coating: Where specified in piping schedule in Section 15051, Buried Piping Installation, coat pipe and fittings with an asphaltic coating approximately one-mil thick, in accordance with ANSI/AWWA C151, ANSI/AWWA C115, ANSI/AWWA C110, and ANSI/AWWA C153, as applicable.

PART 3 – EXECUTION

3.1 INSPECTION

A. Inspect piping to assure that piping is free from defects in material and workmanship. Verify compatibility of pipe, fittings, gaskets, linings, and coatings.

B. Visually inspect at the Site coated or lined pipe and fittings with Engineer and compare to approved Samples to verify lining continuity, surface gloss, and color, as applicable. Notify pipe manufacturer of damaged or unacceptable products. Pipe manufacturer shall visit the Site and perform testing to verify conformance with the Contract Documents to determine if products require replacement or repair. Repair or replace unacceptable products at no cost to Owner.

3.2 INSTALLATION AND FIELD QUALITY CONTROL

A. For buried piping installation and testing, refer to Section 15051, Buried Piping Installation.

B. For exposed piping installation and testing, refer to Section 15052, Exposed Piping Installation.

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SECTION 15063

STAINLESS STEEL PIPE FOR LIQUID SERVICE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install stainless steel pipe, fittings, and fabricated pump suction inlets and pump suction elbows for liquid service.
   2. Extent of piping and fabrications is shown and shall be in accordance with piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before stainless steel piping Work.

C. Related Sections:
   1. Section 15051, Buried Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section include:
   1. ANSI B2.1, Pipe Threads.
   2. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   3. ANSI B16.11 Forged Fittings, Socket Welding and Threaded.
   4. ANSI B36.19, Stainless Steel Pipe (ASME B36.19M).
   5. ASTM A182/A182M, Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   6. ASTM A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   7. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   8. ASTM A276, Specification for Stainless Steel Bars and Shapes.
   9. ASTM A312/A 312M, Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
   10. ASTM A320/A320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
   11. ASTM A403/A403M, Specification for Wrought Austenitic Stainless Steel Piping Fittings.
   12. ASTM A409/A409M, Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
   13. ASTM A480/A480M, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
   14. ASTM A774/A774M, Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
   15. ASTM A778, Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
   16. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   17. AWS D1.6/D1.6M, Structural Welding Code – Stainless Steel.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer's Qualifications: Manufacturer shall have a minimum of five years experience producing stainless steel pipe and fittings for liquid service substantively similar to the materials specified, and shall be able to provide documentation of satisfactory service in at least five completed installations.
   2. Welders shall be qualified in accordance with AWS D1.6.

B. Component Supply and Compatibility:
   1. Obtain all materials included in this Section, regardless of component Supplier, from a single stainless steel pipe manufacturer.
   2. Stainless steel pipe manufacturer shall review and approve to prepare all Shop Drawings and other submittals for all materials furnished under this Section.
   3. Materials shall be suitable for specified service conditions and shall be integrated into overall assembly by stainless steel pipe Supplier.

C. Regulatory Requirements: Comply with applicable provisions of the following.
   1. ASME Boiler and Pressure Vessel Code.
   2. National Fire Protection Association.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Piping layout Shop Drawings in accordance with Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
      b. Plans, elevations, sections, and details for the fabrication and installation of piping, pump suction inlets and pump suction elbows and connections.
      c. Assembly drawings and templates for location and installation of embedded fabrications and anchorage devices.
      d. Clearly indicate on drawings all dimensions and orientations.
      e. Written welding procedures for each type of weld and weld position.
   2. Product Data:
      a. Product data on pipe, fittings, gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certificate of compliance standards referenced in this Section.
   2. Qualifications Statements:
      a. Manufacturer's qualifications when requested by Engineer.
      b. Upon request of the Engineer, provide certification that all welders employed on or to be employed for the work have satisfactorily passed AWS qualification tests within the previous 12 months and are kept current.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
   1. Alaskan Copper & Brass Company.
   2. Felker Brothers Corporation.
   3. Douglas Brothers Division, Robert Mitchell Co., Inc.
   4. Or equal.

2.2 MATERIALS

A. Fabricated Stainless Steel Pipe:
   1. Pipe:
      a. Type: Pipe and fittings less than three-inch diameter shall be seamless. Pipe three-inch diameter and larger may be electrically welded or seamless. Spiral welded pipe is not acceptable.
      b. Material: ASTM A240/A240M, Type 316L stainless steel.
      c. Diameter: Pipe diameters as shown and specified shall mean nominal outside diameter of pipe, except for pipes specified with schedule numbers for wall thickness. Pipes specified with schedule numbers for wall thickness shall conform to ANSI B36.19.
      d. Wall Design Criteria:
         1) Provide a piping that meets fabrication, installation, and service conditions as shown and specified.
         2) Based on internal design pressure indicated for test pressure in Section 15051, Buried Piping Installation,
         3) Minimum Wall Thickness:
            i. Stainless steel piping less than six-inch diameter shall be Schedule 40. Provide stainless steel pipe less than three-inch diameter with threaded connections conforming to ANSI B2.1.
            ii. Stainless steel pipe six-inch diameter through eight-inch diameter shall be Schedule 10S.
            iii. Stainless steel pipe greater than eight-inch diameter shall be Schedule 5S, unless shown otherwise or unless otherwise specified in Section 15051, Buried Piping Installation.
      e. Fabrication of stainless steel pipe shall be in accordance with ASTM A312 and ASTM A778, where applicable. Large-diameter pipe in corrosive or high-temperature applications shall conform with ASTM A409.
         1) Longitudinal Seams: Maximum of two per section of pipe.
         2) Girth Seams: Not less than six feet apart, except at fittings and specials.
         3) Pipe Ends: Perpendicular to longitudinal axis.
         4) Roundness: Tolerance of 1/16-inch.
         5) Straightness: Tolerance of 1/8-inch in ten feet.
         6) Edges: Joint-edges shall be true so as to not leave shoulder on inside of pipe.
      f. Welding:
         1) Longitudinal Welds: Tungsten Inert Gas or Metal Inert Gas.
         2) Circumferential Welds: Heliarc or metallic air process.
         3) Grinding: Interior welds shall be ground smooth to provide internal bead of 1/16-inch or less.
      g. Factory Finish:
         1) Pipe and fittings shall be pickled after manufacture by immersing in acid bath until weld discoloration and iron pickup is removed.
         2) Passivate piping welds after fabrication.

3) Thoroughly wash pipe and fittings with clear water after pickling.

2. Joints:
   a. General:
      1) Comply with Section 15051, Buried Piping Installation.
      2) Provide flanged joints at connections to valves, equipment, instruments, and at such joints where pipe dismantling may be required to facilitate equipment removal and maintenance.
      3) Provide flanged joints for field assembly of exposed and submerged piping.
      4) Joints shall be shop welded, unless otherwise shown or specified.
      5) Stainless steel pipe fabricated into spool pieces shall have shop-welded circumferential butt-welded joints or flanges.
   b. Flanged Joints:
      1) Two-part flange:
         i. Slip-on rolled angle face rings of 1/8-inch stainless steel for pipe less than 16-inch diameter, and 3/16-inch thick for pipe 16-inch diameter and larger. Angle face ring thickness shall be equal to or greater than wall of pipe or fitting to which angle face ring is welded, and continuously weld angle face ring to pipe or fitting on both sides. Angle leg shall not interfere with flange bolt holes.
         ii. Backing Flange: Hot-dipped galvanized ductile-iron drilled to ANSI B16.1 Class 125 standards. For submerged joints, backing flanges shall be stainless steel plate flanges. Minimum flange thickness shall be:

Diameter	Flange Thickness
10 to 12 inches	11/16-inch
14 to 18 inches	3/4inch
20 to 30 inches	1-inch
36 to 54 inches	1-3/8-inch

      2) Welded Ring Flange:
         i. Provide Type 316L stainless steel ring flanges welded to pipes and fittings. Conform to AWWA C228 Class SD (150 psi) for flange thickness and drilling, unless shown otherwise.
         ii. Test flanges for true plane after welding and reface, if required.
         iii. Flanges shall be free of nicks and gouges.
         iv. Conform to the welding requirements of Paragraph 2.2.A.1.f, above.
      3) Gaskets:
         i. Comply with stainless steel pipe manufacturer's recommendations for service conditions shown and as specified.
         ii. Gaskets provided on compressed air service, including process air and channel air service, shall be neoprene or EPDM suitable for minimum 25 psi pressure and 250 degrees F air temperature.
      4) Bolts and Nuts:
         i. Provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.
         ii. For low-temperature service, comply with ASTM A320/A320M. For high-temperature service, comply with ASTM A193/A193M.

3. Fittings:
   a. Type: Welded or flanged as shown, all stainless steel.
   b. Construction:
      1) Stainless steel fittings, 2.5-inch diameter and smaller, shall be ASTM A403/A403M, of same material and pressure rating as associate pipe, threaded, long-radius with dimensions conforming to ANSI B16.11.

2) Unless otherwise specified, stainless steel fittings three-inch diameter and larger shall be of same material and same thicknesses as associated pipe. Long-radius elbows up to 24-inch diameter shall be smooth flow. Short-radius, special-radius, and reducing bends, and long-radius bends greater than 24-inch diameter, shall be mitered construction. Reducers shall be tapered, cone type. Tees, crosses, laterals, and wyes shall be shop-fabricated pipe.
3) For general corrosive service at low and moderate temperatures, comply with ASTM A774/A774M.

c. Wall Thickness: Conform to wall thickness specified in Section 15052, Exposed Piping Installation, but in no case less than pipe wall thickness.
d. Base Fitting: Provide Type 316L stainless steel.

4. Threaded Connections: Threaded pipe, gage, or instrument connections shall be made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182/A182M or ASTM A276, shop welded to pipe at locations specified or shown.

B. Specials:
1. Provide fabricated pump suction inlets and pump suction elbows as shown on the Drawings.
2. Provide concrete anchors welded to the surface of piping and fabrications as shown on the Drawings.
3. Taps:
a. Provide taps as shown or required for small pipe and instrument connections.
b. Connections shall be welded, forged threaded Type 316L stainless steel boss.
4. Pipe Adapters: Where necessary to join pipe of different type, provide necessary adapters. Ends shall conform to the Specifications for appropriate type joint.

C. Welding of Pipe:
1. Welding performed under this Section shall be completed in shop. Field welding is not allowed. Welding shall conform to AWS D1.6.
2. Stainless steel joining welds shall be made using fully automatic, inert gas process. Before welding longitudinal butt seal, starting and run-off tabs shall be heliarc spot welded to each end of pipe. Ends shall be checked for trueness to axis. Rigid jigs and fixtures shall be used for holding parts in proper alignment during welding.
3. During welding, joint shall be backed up from opposite side with chill bar. Chill bar shall have series of holes running its entire length through which gas is introduced to assure shielding to interior of joint. Welding of joint shall be by automatic arc, inert gas method. Gas shield shall be utilized top and bottom to assure that weld is made in completely inert atmosphere.
4. Filler wire shall be added to all gauges of material to provide cross section of weld metal equal to or greater than parent metal. Filler wire shall be at least one grade higher than parent metal and always of extra low carbon grade. Filler wire shall be automatically fed to weld with rate of travel of automatic welding machine. Use non-consumable tungsten electrode, with shielding gas being either argon or helium.
5. Welds shall be fully penetrated, sound, and of uniform bead. Circumferential welds shall be made using tungsten shielded arc process. Welds shall have full penetration to interior surface of pipe. Provide gas shielding to interior of joint as well as to exterior, to assure that weld is made in completely inert atmosphere.
6. Welds shall have surface finish equal to smoothness of 2D sheet finish. Interior weld beads shall be smooth, evenly distributed, with interior projection not exceeding 1/16-inch beyond inside diameter of pipe or fitting. Ripples or unevenness shall be finely ground to meet above requirements. Major grinding of interior seams to remove excess projection of welds or severe unevenness is not allowed.
7. Outside weld area shall be wire brushed. Brushes shall be of stainless steel and used only on stainless steel material. Exterior discoloration and deposits left by welding shall be removed mechanically with wire brushes or non-metallic abrasives.

2.3 FINAL CLEANING

A. After fabrication, mechanically clean accessible weld surfaces with wire brushes or non-metallic abrasives.

B. Pipe, fittings, and flanges shall be free of iron particulates and other foreign material.

2.4 IDENTIFICATION

A. Pipe and fitting materials shall be stamped, marked, or identified with the following:
   1. Name of manufacturer.
   2. Date of manufacture.
   3. Operating design pressure at operating design temperature.
   4. Type of service.
   5. Manufacturer's part number.

PART 3 – EXECUTION

3.1 INSPECTION

A. Inspect pipe materials for defects in material and workmanship. Verify compatibility of pipe and fittings.

3.2 INSTALLATION

A. Do not handle stainless steel piping and fabrications with non-stainless steel equipment.

B. Brace embedded piping, pump suction inlets, and pump suction elbows internally during placement of concrete.

C. Ensure that piping, pump suction inlets, and pump suction elbows are properly aligned and anchored and that flanges are properly aligned to mate with connecting piping and equipment.

D. Inspection of pump suction inlets and pump suction elbows: All welds will be subject to visual inspection. Where visibly deficient welds are observed, the welds will be tested using nondestructive methods by a certified testing laboratory. If welds are found to be satisfactory, Owner will pay for testing. If welds are found to be unacceptable or deficient, the Contractor will pay for testing. The Contractor will correct improper workmanship, remove and replace, or correct as instructed, all welds found unacceptable or deficient. The Contractor will pay for all corrections and subsequent tests required to confirm the integrity of the weld.

E. For buried piping installation and testing, refer to Section 15051, Buried Piping Installation.

F. For exposed piping installation and testing, refer to Section 15052, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 15064

STAINLESS STEEL PIPE FOR PROCESS AIR SERVICE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, test and place into satisfactory operating condition type 316 stainless steel pipe, fittings, and fabricated elbows for process air service.
   2. Extent of piping and fabrications is as shown on the contract drawings.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before stainless steel piping Work.

1.2 DESCRIPTION

A. Standards referenced in this Section include:
   1. ANSI B2.1, Pipe Threads.
   2. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   3. ANSI B16.11 Forged Fittings, Socket Welding and Threaded.
   4. ANSI B36.19, Stainless Steel Pipe (ASME B36.19M).
   5. ASTM A182/A182M, Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   6. ASTM A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   7. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   8. ASTM A276, Specification for Stainless Steel Bars and Shapes.
   9. ASTM A312/A 312M, Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
   10. ASTM A320/A320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
   11. ASTM A403/A403M, Specification for Wrought Austenitic Stainless Steel Piping Fittings.

12. ASTM A409/A409M, Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
13. ASTM A480/A480M, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
14. ASTM A774/A774M, Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
15. ASTM A778, Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
16. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
17. AWS D1.6/D1.6M, Structural Welding Code – Stainless Steel.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer's Qualifications: Manufacturer shall have a minimum of five years' experience producing 316 stainless steel pipe and fittings for process air service substantively similar to the materials specified and shall be able to provide documentation of satisfactory service in at least five completed installations.
   2. Welders shall be qualified in accordance with AWS D1.6.

B. Component Supply and Compatibility:
   1. Obtain all materials included in this Section, regardless of component Supplier, from a single 316 stainless steel pipe manufacturer.
   2. Stainless steel pipe manufacturer shall prepare all Shop Drawings and other submittals for all materials furnished under this Section.
   3. Materials shall be suitable for specified service conditions and shall be integrated into overall assembly by stainless steel pipe Supplier.

C. Regulatory Requirements: Comply with applicable provisions of the following.
   1. ASME Boiler and Pressure Vessel Code.
   2. National Fire Protection Association.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Piping layout Shop Drawings.
      b. Plans, elevations, sections, and details for the fabrication and installation of all process air piping, fittings, and connections.
      c. Assembly drawings and templates for location and installation of fabrications and anchorage devices.

d. Clearly indicate on drawings all dimensions and orientations.
e. Written welding procedures for each type of weld and weld position.

2. Product Data:
   a. Product data on pipe, fittings, gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
1. Certificates:
   a. Certificate of compliance standards referenced in this Section.
2. Qualifications Statements:
   a. Manufacturer's qualifications when requested by Engineer.
   b. Upon request of the Engineer, provide certification that all welders employed on or to be employed for the work have satisfactorily passed AWS qualification tests within the previous 12 months and are kept current.

1.5 DELIVERY, STORGE AND HANDLING

A. Stored in a clean dry environment with each pipe section and fitting capped at both ends.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
1. Alaskan Copper & Brass Company.
2. Felker Brothers Corporation.
3. Douglas Brothers Division, Robert Mitchell Co., Inc.
4. Or equal.

2.2 MATERIALS

A. Fabricated Stainless Steel Pipe:
1. Pipe:
   a. Type: Pipe and fittings less than three-inch diameter shall be seamless. Pipe three-inch diameter and larger may be electrically welded or seamless. Spiral welded pipe is not acceptable.
   b. Material: ASTM A240/A240M, Type 316L stainless steel.
   c. Diameter: Pipe diameters as shown and specified shall mean nominal outside diameter of pipe, except for pipes specified with schedule numbers for wall thickness. Pipes specified with schedule numbers for wall thickness shall conform to ANSI B36.19.

d. Wall Design Criteria:
   1) Provide piping that meets fabrication, installation, and service conditions as shown and specified.
   2) Minimum Wall Thickness:
      i. Stainless steel type 316 process air piping less than 12-inch diameter shall be Schedule 40. Provide stainless steel pipe less than three-inch diameter with threaded connections conforming to ANSI B2.1.
      ii. Stainless steel type 316 process air pipe 12-inch diameter and greater shall be Schedule 10S, unless shown otherwise or unless otherwise specified in Section 15052, Exposed Piping Installation.

e. Fabrication of stainless steel pipe shall be in accordance with ASTM A312 and ASTM A778, where applicable. Large-diameter pipe in corrosive or high-temperature applications shall conform with ASTM A409.
   1) Longitudinal Seams: Maximum of two per section of pipe.
   2) Girth Seams: Not less than six feet apart, except at fittings and specials.
   3) Pipe Ends: Perpendicular to longitudinal axis.
   4) Roundness: Tolerance of 1/16-inch.
   5) Straightness: Tolerance of 1/8-inch in ten feet.
   6) Edges: Joint-edges shall be true so as to not leave shoulder on inside of pipe.

f. Welding:
   1) Longitudinal Welds: Tungsten Inert Gas or Metal Inert Gas.
   2) Circumferential Welds: Heliarc or metallic air process.
   3) Grinding: Interior welds shall be ground smooth to provide internal bead of 1/16-inch or less.

g. Factory Finish:
   1) Pipe and fittings shall be pickled after manufacture by immersing in acid bath until weld discoloration and iron pickup is removed.
   2) Passivate piping welds after fabrication.
   3) Thoroughly wash pipe and fittings with clear water after pickling.

g. Fabrication:
   1) Completely immerse all stainless steel assemblies and parts after welding, fabrication, and wire brushing, in an acid solution as specified in ASTM A380-88, Section 6.2.11. The acid shall be a nitric-hydrofluoric solution as defined in Table A2.1, Annex A2 of ASTM A380. Provide a final rinse using ordinary industrial or potable water and dry in conformance with Section 8.3 of ASTM A380. Corrosion protection techniques not employing full immersion methods will not be acceptable.
   2) At least two weeks prior to cleaning the equipment the Manufacturer shall notify the ENGINEER of the schedule so that the ENGINEER can observe the procedure, if desired. If full immersion pickling is not

observed by the ENGINEER, the Manufacturer shall verify that cleaning has been performed per the above specifications. Non-properly cleaned equipment will be cause for rejection of the system.

3) Perform welding by ASME certified welders in conformation with standard procedures.
4) Piping with wall thickness up to 0.125 inch will be welded with the TIG (GTAW) process.
5) Heavier walls will be properly beveled and have a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW), MIG (GMAW), or metallic arc (SMAW) process.
6) Filler wire of ELC grades only is to be added to all welds to provide a cross section at the weld equal to or greater than the parent metal.
7) Weld deposit is to be smooth and evenly distributed and have a crown of no more than 1/16 inch on the I.D. and 3/32 inch on the O.D. of the piping.
8) Concavity, undercut, cracks or crevices will not be allowed.
9) Butt welds will have full penetration to the interior surface, and inert gas shielding will be provided to the interior and exterior of the joint.
10) Excessive weld deposits, slag, spatter, and projections is to be removed by grinding.
11) Angle face rings will be continuously welded on both sides to the pipe or fitting.
12) Welds on gasket surfaces will be ground smooth.
13) After welding, all exterior welded joints are to be treated with a pickling solution, brushed with stainless wire brushes and rinsed clean.

2. Joints:
   a. General:
      1) Furnish and install stainless steel type 316 sleeve type couplings that are restrained, restrained/rigid, restrained/flexible, or flexible as shown on the Contract Drawings.
      3) Comply with plans for locations of connections.
      4) Provide flanged joints at connections to valves, equipment, instruments, and at such joints where pipe dismantling may be required to facilitate equipment removal and maintenance.
      5) Provide flanged joints for field assembly of exposed and submerged piping.
      6) Joints shall be shop welded, unless otherwise shown or specified.
      7) Stainless steel pipe fabricated into spool pieces shall have shop-welded circumferential butt-welded joints or flanges.
   b. Flanged Joints:
      1) Two-part flange:

i. Slip-on rolled angle face rings of 1/8-inch stainless steel for pipe less than 16-inch diameter, and 3/16-inch thick for pipe 16-inch diameter and larger. Angle face ring thickness shall be equal to or greater than wall of pipe or fitting to which angle face ring is welded, and continuously weld angle face ring to pipe or fitting on both sides. Angle leg shall not interfere with flange bolt holes.

ii. Backing Flange: Type 316 stainless steel drilled to ANSI B16.1 Class 125 standards. For submerged joints, backing flanges shall be stainless steel plate flanges. Minimum flange thickness shall be:

Diameter	Flange Thickness
10 to 12 inches	11/16-inch
14 to 18 inches	3/4inch
20 to 30 inches	1-inch
36 to 54 inches	1-3/8-inch
56 to 66 inches	2-inch

2) Welded Ring Flange:
   i. Provide Type 316L stainless steel ring flanges welded to pipes and fittings. Conform to AWWA C228 Class SD (150 psi) for flange thickness and drilling, unless shown otherwise.
   ii. Test flanges for true plane after welding and reface, if required.
   iii. Flanges shall be free of nicks and gouges.
   iv. Conform to the welding requirements of Paragraph 2.2.A.1.f, above.
3) Gaskets:
   i. Comply with stainless steel pipe manufacturer's recommendations for service conditions shown and as specified.
   ii. Gaskets provided on compressed air service, including process air and channel air service, shall be neoprene or EPDM suitable for minimum 25 psi pressure and 300 degrees F air temperature.
4) Bolts and Nuts:
   i. Provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.
   ii. For low-temperature service, comply with ASTM A320/A320M. For high-temperature service, comply with ASTM A193/A193M.

3. Fittings:
    a. Type: Welded or flanged as shown, all stainless steel.
    b. Construction:
        1) Stainless steel fittings, 2.5-inch diameter and smaller, shall be ASTM A403/A403M, of same material and pressure rating as associate pipe, threaded, long-radius with dimensions conforming to ANSI B16.11.
        2) Unless otherwise specified, stainless steel fittings three-inch diameter and larger shall be of same material and same thicknesses as associated pipe. Long-radius elbows up to 24-inch diameter shall be smooth flow. Short-radius, special-radius, and reducing bends, and long-radius bends greater than 24-inch diameter, shall be mitered construction. Reducers shall be tapered, cone type. Tees, crosses, laterals, and wyes shall be shop-fabricated pipe.
        3) For general corrosive service at low and moderate temperatures, comply with ASTM A774/A774M.
    c. Wall Thickness: Conform to wall thickness specified above but in no case less than pipe wall thickness.
    d. Base Fitting: Provide Type 316L stainless steel.
4. Threaded Connections: Threaded pipe, gage, or instrument connections shall be made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182/A182M or ASTM A276, shop welded to pipe at locations specified or shown.

B. Specials:
1. Provide fabricated elbows as shown on the Drawings.
2. Provide stainless steel anchors welded to the surface of piping and fabrications as shown on the Drawings.
3. Taps:
    a. Provide taps as shown or required for small pipe and instrument connections.
    b. Connections shall be welded, forged threaded Type 316L stainless steel boss.
4. Pipe Adapters: Where necessary to join pipe of different type, provide necessary adapters. Ends shall conform to the Specifications for appropriate type joint.

C. Welding of Pipe:
1. Welding performed under this Section shall be completed in shop. Field welding shall be minimized. Welding shall conform to AWS D1.6. Twenty percent of welds shall be Xray tested.
2. Stainless steel joining welds shall be made using fully automatic, inert gas process. Before welding longitudinal butt seal, starting and run-off tabs shall be heliarc spot welded to each end of pipe. Ends shall be checked for trueness to

axis. Rigid jigs and fixtures shall be used for holding parts in proper alignment during welding.

3. During welding, joint shall be backed up from opposite side with chill bar. Chill bar shall have series of holes running its entire length through which gas is introduced to assure shielding to interior of joint. Welding of joint shall be by automatic arc, inert gas method. Gas shield shall be utilized top and bottom to assure that weld is made in completely inert atmosphere.
4. Filler wire shall be added to all gauges of material to provide cross section of weld metal equal to or greater than parent metal. Filler wire shall be at least one grade higher than parent metal and always of extra low carbon grade. Filler wire shall be automatically fed to weld with rate of travel of automatic welding machine. Use non-consumable tungsten electrode, with shielding gas being either argon or helium.
5. Welds shall be fully penetrated, sound, and of uniform bead. Circumferential welds shall be made using tungsten shielded arc process. Welds shall have full penetration to interior surface of pipe. Provide gas shielding to interior of joint as well as to exterior, to assure that weld is made in completely inert atmosphere.
6. Welds shall have surface finish equal to smoothness of 2D sheet finish. Interior weld beads shall be smooth, evenly distributed, with interior projection not exceeding 1/16-inch beyond inside diameter of pipe or fitting. Ripples or unevenness shall be finely ground to meet above requirements. Major grinding of interior seams to remove excess projection of welds or severe unevenness is not allowed.
7. Outside weld area shall be wire brushed. Brushes shall be of stainless steel and used only on stainless steel material. Exterior discoloration and deposits left by welding shall be removed mechanically with wire brushes or non-metallic abrasives.

2.3 INSULATION

A. Process air piping within the Blower Building shall be insulated and jacketed. Insulation shall be cellular glass, 2 inches thick with Type 316 stainless steel jacketing. In all other respects cellular glass insulation and jacketing shall be in accordance with Specification Section 15082 - Pipe Insulation For HVAC Systems.

2.4 FINAL CLEANING

A. After fabrication, mechanically clean accessible weld surfaces with wire brushes or non-metallic abrasives.

B. Pipe, fittings, and flanges shall be free of iron particulates and other foreign material.

2.5 IDENTIFICATION

A. Pipe and fitting materials shall be stamped, marked, or identified with the following:
   1. Name of manufacturer.
   2. Date of manufacture.
   3. Operating design pressure at operating design temperature.
   4. Type of service.
   5. Manufacturer's part number.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect pipe materials for defects in material and workmanship. Verify compatibility of pipe and fittings.

3.2 INSTALLATION

A. Do not handle stainless steel piping and fabrications with non-stainless steel equipment. Use extreme care to avoid the contact of any ferrous materials with the stainless steel piping. All saws, drills, files, wire brushes, etc. are to be used for stainless steel piping only. Pipe storage and fabrication racks are to be non-ferrous or stainless steel or rubber lined. Use nylon slings or straps for handling stainless steel piping.

B. Brace embedded piping, and fittings internally during placement of concrete.

C. Ensure that piping and fittings are properly aligned and anchored and that flanges are properly aligned to mate with connecting piping, valves, instruments and equipment.

D. Inspection of fittings: All welds will be subject to visual inspection. Where visibly deficient welds are observed, the welds will be tested using nondestructive methods by a certified testing laboratory. If welds are found to be satisfactory, Owner will pay for testing. If welds are found to be unacceptable or deficient, the Contractor will pay for testing. The Contractor will correct improper workmanship, remove and replace, or correct as instructed, all welds found unacceptable or deficient. The Contractor will pay for all corrections and subsequent tests required to confirm the integrity of the weld.

E. Install all pipes, fittings, couplings, joints, supports, hangers, restrains as shown on the drawings.

F. After installation, remove all foreign matter from the piping surface and flush or blow out all materials from interior surfaces.

G. If rusting of embedded iron occurs, pickle the affected surface with Oakite Deoxidizer SS or approved equal, scrub with stainless steel brushes and rinse clean.

H. Perform field welding by certified welders. Submit welder certificates to the Engineer.

I. For exposed piping installation and testing, refer to Section 15052, Exposed Piping Installation.

3.3 PAINTING

A. Do not paint the stainless steel pipe.

B. Supply and install the stainless steel piping with a consistent clean surface.

C. Remove identifying spool piece marks with paint thinner or solvents. The entire stainless steel surface shall be washed with detergent and hot water and rinsed clean.

D. Final marking of the pipeline is to be in accordance with Section 09900 - Painting.

3.4 FIELD QUALITY CONTROL

A. Leakage: Test pipes at 16 psig.

B. Remove all dirt, oil, grease and foreign material before testing.

C. Install all temporary plugs, caps, supports, restraints, meters, valves, equipment, compressor, pressure gages and pipe connections.

D. Add air slowly until air pressure reaches 16 psig.

E. If the gauge needle does not drop for two hours, the test section will be considered to have passed air test.

F. Observe air leaks.

G. There is to be no air leakage.

H. If the pipe section fails to pass

I. the pressure and leakage test, replace or repair defective pipe, joints, fittings at no cost to the OWNER.

J. Repeat above tests until the leakage has been fixed.

K. Remove all temporary items.

L. When pipe is under pressure test, operate all valves in the test section through a complete cycle of closing and opening.

M. Apply test pressure to each valve from one end when valve is in the closed position.

N. There is to be no visible leakage through valves.

O. Remove all temporary items.

+ + END OF SECTION + +

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SECTION 15065

CONCRETE PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install reinforced concrete pressure pipe and pre-stressed concrete cylinder pressure pipe and fittings.
   2. Extent of concrete pipe to be provided is shown and specified in piping schedules included in Section 15051, Buried Piping Installation.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before concrete pipe work.

C. Related Sections:
   1. Section 15051, Buried Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AASHTO, Policy on Geometric Design of Highways and Streets.
   2. ANSI/ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   3. ANSI/ASTM A82, Specification for Steel Wire, Plain for Concrete Reinforcement.
   4. ASTM A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   5. ANSI/ASTM A283/A283M, Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   6. ANSI/ASTM A496, Specification for Steel Wire, Deformed, for Concrete Reinforcement.
   7. ANSI/ASTM A497/A497M, Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   8. ANSI/ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   9. ANSI/ASTM A663/A663M, Specification for Steel Bars, Carbon, Merchant Quality Mechanical Properties.
   10. ANSI/ASTM A1011/1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   11. ANSI/ASTM A1018/1018M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   12. ANSI/ASTM C14, Specification for Concrete Sewer, Storm Drain and Culvert Pipe.
   13. ANSI/ASTM C33, Specification for Concrete Aggregates.
   14. ANSI/ASTM C76, Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.
   15. ANSI/ASTM C150, Specification for Portland Cement.
   16. ANSI/ASTM C595, Specification for Blended Hydraulic Cements.
   17. ANSI/ASTM C1433, Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers.

18. ANSI/AWWA C207, Steel Pipe Flanges for Waterworks Service-Sizes 4-inch through 144-inches.
19. ANSI/AWWA C301, Prestressed Concrete Pressure Pipe, Steel Cylinder Type.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have a minimum of five years of experience producing concrete pipe and fittings, and shall be able to document satisfactory service in at least five installations.

B. Component Supply and Compatibility:
   1. Each type of concrete pipe and associated fittings shall be products of one manufacturer.
   2. Concrete pipe Supplier shall review, approve, and prepare all Shop Drawings and submittals for all components furnished under this Section.
   3. Components shall be suitable for specified service conditions.

C. Quality of materials, process of manufacture, and finished pipe shall be subject to inspection by Engineer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed drawings and data on piping and fittings, where applicable, and appurtenances. Submit with Shop Drawings required under Section 15051, Buried Piping Installation.
   2. Product Data:
      a. Detailed product data on pipe, fittings, gaskets, fastening hardware where applicable, and appurtenances. Submit with Shop Drawings required under Section 15051, Buried Piping Installation.

B. Informational Submittals: Submit the following:
   1. Certifications:
      a. Submit certificate signed by manufacturer of each product certifying that products conform to applicable referenced standards.
   2. Supplier Instructions:
      a. Pipe manufacturer instructions for handling, storing, and installing products.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 15051, Buried Piping Installation.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:
   1. Pipe shall be designed for an external live loading, including impact, equal to AASHTO H-20 loading with earth cover as shown.

B. Service Conditions:
   1. Internal Working Pressure: 12psig

2. Internal Transient Pressure: 40 psi
3. Internal Field Test Pressure: 15 psi
   Refer to Section 15051, Table 15051-A, Buried Piping Schedule and Contract Drawings.
4. pH Range of Pipe Contents: 5.0 to 9.0.

2.2 MATERIALS, CONCRETE PRESSURE PIPE

A. Pipe and fittings shall conform to requirements of ANSI/AWWA C301. Pipe shall have the following features: welded steel cylinder with steel joint rings welded to its ends; steel cylinder encased in concrete, reinforcement consisting of high-tensile wire wound around outside of the core in one or more layers at a predetermined stress and securely fastened at its ends; coating of dense mortar or concrete covering the core and wire, except surfaces of joint rings; self-centering joint with watertight preformed rubber gasket. For embedded cylinder pipe at least one-third of total core thickness shall be outside of cylinder. Embedded cylinder pipe shall be used in sizes 54-inches and larger. For pipe 16-inch to 48-inch diameter, lined cylinder pipe may be used, with a core of concrete lining inside of steel cylinder. Fittings shall be fabricated from welded steel sheet or plate, and be lined and coated with cement mortar.

B. Pipe Materials:
   1. Cement for concrete work in accordance with ANSI/ASTM C150, Type I.
   2. Aggregates for concrete work in accordance with ANSI/ASTM C33.
   3. Steel for cylinders, joint and fittings in accordance with ANSI/ASTM A1011/1011M, ANSI/ASTM A1018/1018M or ANSI/ASTM A283/A283M.
   4. Steel for reinforcing in accordance with ANSI/ASTM A663/A663M, Grade 80; ANSI/ASTM A615/A615M, Grade 40; or ANSI/ASTM A497/A497M.
   5. Rubber for gaskets shall contain not less than 50 percent by volume of first-grade natural crude or first-grade synthetic rubber. Remainder of compound shall consist of pulverized fillers, free of rubber substitutes, reclaimed rubber, and other deleterious substances.

2.3 MATERIALS, REINFORCED CONCRETE PIPE FOR CULVERTS, STORM DRAINS, AND SEWERS

A. Pipe and fittings shall conform to requirements of ANSI/ASTM C76. Pipe shall be free of fractures and surface roughness. Ends of pipe shall be normal to the walls and center of pipe. Joints shall be designed so that, when sections are laid together, they make a continuous line of pipe with smooth interior free of irregularities in flow line.

B. Pipe Materials:
   1. Cement for concrete work shall be in accordance with, ANSI/ASTM C150 or ANSI/ASTM C595.
   2. Aggregates shall conform to ANSI/ASTM C33.
   3. Steel wire bar reinforcement shall be in accordance with ANSI/ASTM A82 or ANSI/ASTM A496.
   4. Steel wire fabric reinforcement shall be in accordance with ASTM A1064.

C. Pipe shall be Class V. Quality of materials, process of manufacture and finished pipe shall be subject to inspection and approval by Engineer.

2.4 MATERIALS, PRECAST REINFORCED CONCRETE BOX SECTIONS FOR CULVERTS, STORM DRAINS, AND SEWERS

A. Reinforced concrete box sections shall conform to requirements of ANSI/ASTM C1433. Box sections shall be type Table 2. Ends shall be male and female so that when sections are laid together they make a continuous line with smooth interior pipe free of irregularities in flow line.

B. Construction Materials:
   1. Steel wire reinforcement shall be in accordance with, ANSI/ASTM A82 or ANSI/ASTM A496.
   2. Steel wire fabric reinforcement shall be in accordance with ASTM A1064 or ANSI/ASTM A497/A497M.
   3. Cement for concrete work shall be in accordance with, ANSI/ASTM C150.
   4. Aggregates shall conform to ANSI/ASTM C33.

2.5 PIPE CLOSURES

A. Pipe layout submitted by Supplier shall reflect Contractor's planned schedule for operations and the Progress Schedule. Pipe closures shall be designed by pipe manufacturer for pressure required and shall be located in straight runs of pipe. Number, design, and location of closure pieces shall be as shown or subject to approval of Engineer.

B. Contractor may either cut closure cylinder to required length in field or, if time allows, have pipe manufacturer supply required length based on exact field measurements.

C. Extra payment will not be made for closures. Extra compensation will not be paid for concrete required for protecting cylinder and joint rings.

2.6 WALL FITTINGS

A. Unless otherwise shown on the Drawings connect to structures by casting a fabricated bell wall fitting into concrete. Fabricated bell wall fitting shall consist of a bell ring suitable for connecting to steel spigot, steel pipe section, and waterstop ring, all welded together to form a complete unit, with a laying length equal to width of wall in which it is installed. For restrained joints, provide additional length to accommodate bell-bolt, harnessed clamp, or snap ring connection. Fitting shall have a welded fabric or wire mesh reinforced mortar lining furnished to interior diameter of connecting pipeline.

B. Connect flanged piping to special fabricated flange wall fittings where shown. Fabricated flange wall fitting shall consist of a steel flange, steel pipe section, waterstop ring, and a bell ring suitable for connecting steel spigot to be provided, all welded together to form a complete unit, with a laying length equal to width of wall in which it is installed. Fitting shall have a welded fabric or wire-mesh reinforced mortar lining finished to interior diameter of connecting pipe. Flange shall be stress-relieved after welding to steel pipe section and then machined. Drill and tap flange to receive stud bolts. Flange shall conform to AWWA C207 for steel flanges, Class D, with ANSI B16.1, Class 125 drilling.

2.7 MARKING FOR IDENTIFICATION

A. All pipeline materials shall be stamped, marked, or identified with the following information:
   1. Name or trademark of manufacturer.
   2. Pipe class and specification designation.
   3. Size and length dimensions.
   4. Date and place of manufacture.
   5. Pipe 24-inches and larger shall also be marked on pipe interior as above.
   6. Name of Owner.

PART 3 – EXECUTION

3.1 INSTALLATION

A. For buried piping installation, refer to Section 15051, Buried Piping Installation.

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SECTION 15066

COPPER PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish copper pipe and fittings.
   2. Extent of piping is shown and indicated in the piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before copper pipe work.

C. Related Sections:
   1. Section 15051, Buried Piping Installation.
   2. Section 15052, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/ASME B16.15, Cast Copper Alloy Threaded Fittings: Classes 125 and 150.
   2. ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   3. ANSI/ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500 and 2500.
   4. ANSI/ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
   5. ANSI/ASME B16.29, Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings: DWV
   6. ANSI/ASME B16.39, Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300.
   7. ANSI/ASME B16.42, Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
   8. ANSI/ASME B16.50, Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings.
   9. ANSI/ASME B18.2.1, Square and Hex Bolts and Screws, Inch Series.
   10. ANSI/ASME B18.2.2, Square and Hex Nuts.
   11. ASTM A194, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   12. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   13. ASTM B32, Specification for Solder Metal.
   14. ASTM B68, Specification for Seamless Copper Tube, Bright Annealed.
   15. ASTM B88, Specification for Seamless Copper Water Tube.
   16. ASTM B302, Specification for Threadless Copper Pipe, Standard Sizes.
   17. ASTM B306, Specification for Copper Drainage Tube (DWV).
   18. ASTM D1330, Specification for Rubber Sheet Gaskets.
   19. FS WW-U-516, Unions – Brass or Bronze.
   20. NSF/ANSI 61, Drinking Water System Components - Health Effects.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single copper pipe manufacturer.

2. Copper pipe Supplier shall review and approve or prepare all Shop Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.

B. Regulatory Requirements:
1. Pipe and fittings that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF/ANSI 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at the Site.
2. Pipe and fittings materials and joint types shall comply with requirements of authorities having jurisdiction at Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following with Shop Drawings required under Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation:
1. Shop Drawings:
a. Detailed layout drawings for pipe, fittings, and appurtenances.
2. Product Data:
a. Detailed data on pipe, fittings, and appurtenances.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Submit certificate signed by manufacturer of each material that material conforms to applicable referenced standards and the Contract Documents.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. Maintain ASTM B68 pipe, fittings, and appurtenances free of scale and dirt during transportation, delivery, storage, and handling.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Potable Water Pipe:
1. Pipe Materials: Comply with ASTM B88.
2. For interior, exposed pipe, provide Type L, hard-drawn tube.
3. For buried pipe and for exterior, exposed pipe, provide Type K, soft-annealed tube.
4. Fittings shall be soldered except at valves, which may be flared or flanged joints.

B. Brazed Copper Pipe: Assemble piping with braze joint pressure fittings. Pipe material shall comply with ASTM B302.

C. Copper Drainage Pipe: Pipe for sanitary drainage or soil, waste, and vent applications shall comply with ASTM B306.

2.2 JOINTS

A. Refer to piping schedules at the end of Sections 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation for the service and joint type specified for each piping system.

B. Provide type of fittings corresponding to the specified joint type in accordance with Table 15066-A.

TABLE 15066-A
COPPER PIPE JOINT TYPE AND FITTING SCHEDULE

Joint Type	Fitting Type, Applicable Reference Standards
Soldered	ANSI/ASME B16.22, ANSI/ASME B16.29 (DWV)
Threaded	ANSI/ASME B16.15
Brazed	ANSI/ASME B16.50
Flared	ANSI/ASME B16.26
Flanged	ANSI/ASME B16.24 (bronze), ANSI/ASME B16.42 (ductile iron at dielectric connections)

C. When fully developed, the strength of the joint shall be greater than strength of adjoining pipe.

D. Flanged Joints for Potable Water Service: Comply with the following:
   1. Flanges: ANSI/ASME B16.24, Class 150.
   2. Gaskets: Red rubber, ASTM D1330, Grade 1, 1/8-inch thick.
   3. Bolts: ASTM A307, Grade B. Conform to ANSI/ASME B18.2.1.
   4. Nuts: ASTM A194, Grade 2H, Heavy hex. Comply with ANSI/ASME B18.2.2.

E. Unions for Potable Water Service: Shall be bronze, 250-pound class, conforming to FS WW-U-516.

F. Dielectric Connections for Potable Water Service:
   1. Manufacturers: Provide products of one of the following:
      a. Watts Regulator Company.
      b. Wilkins, a Zurn company.
      c. Or equal.
   2. Type: Union or flanged.
   3. Ratings:
      a. Unions: Rated for 250 psi, complying with ANSI/ASME B16.39.
      b. Flanges: Rated for 175 psi, complying with ANSI/ASME B16.42 (Ductile Iron), or ANSI/ASME B16.24 (Bronze).
   4. Bodies and flanges, and bolts and nuts shall be steel with galvanized coating. Insulator shall be nylon; tailpiece shall be brass. Provide EPDM gaskets for pipe temperature up to 200 degrees F, and Viton gaskets for temperatures over 200 degrees F.

2.3 MARKING

A. Mark or label all materials with the following:
   1. Metal or alloy designation.
   2. Temper.
   3. Size and schedule.
   4. ASTM reference standard number.
   5. Name and location of Supplier.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Refer to Section 15051, Buried Piping Installation, for buried piping installation, disinfection, testing and cleaning.

B. Refer to Section 15052, Exposed Piping Installation, for exposed piping installation, disinfection, testing and cleaning.

C. Refer to Section 15082, Insulation of Piping and Equipment, for requirements for piping specified as insulated in the piping schedules at the end of Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 15075

MECHANICAL SYSTEM IDENTIFICATION FOR HVAC SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This Section describes the marking and identification materials for identifying mechanical (HVAC) equipment, ductwork and piping systems.

B. Mark and identify all mechanical (HVAC) equipment, ductwork and piping systems described herein, and as shown and specified in the Contract Documents.

1.02 REFERENCES

A. ANSI A13.1 - Scheme for the Identification of Piping Systems.

B. Z53.1 - Safety Color Code for Marking Physical Hazards.

C. OSHA 29 CFR 1910 - Subpart J, General Environmental Controls

1.03 SUBMITTALS

A. Identification Scheme - Submit scheme of identification codes.

B. Valve Schedules - Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Samples - Submit samples of tags, attachments, labeled and identified.

D. Equipment Schedules - Submit mechanical equipment schedules, listing proposed equipment numbers, and their location and function.

E. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Seton

B. Bunting

C. W.H. Brady Company

2.02 VALVE TAGS

A. Provide valve tags for all valves installed for this project. Valve tags shall be constructed of brass with stamped letters and service designation tag size minimum 1-1/2 inches (38 mm) diameter with smooth edges, brass S hook.

B. Valve tags shall be permanently stamped and marked with a service designation, normal valve position, and an identifying number as large as possible. Each valve shall have a separate and distinct number coordinated with the service designations shown on the Drawings and the Owners existing valve numbering system. Coordinate with the Engineer and Owner before finalizing the valve tag numbering system.

2.03 PIPE MARKERS

A. All accessible piping installed indoors for this project, insulated and uninsulated shall be identified with wraparound pipe markers. Pipe markers shall be factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. "Accessible" piping shall include exposed piping, and piping located above lay-in ceilings. Markers shall include system name, flow arrow, and color code and pipe diameter.

B. All piping installed outdoors for this project, insulated and uninsulated, shall be identified with wraparound pipe markers. Pipe markers shall be factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. The marker shall be printed with weather-resistant ink.

C. Where pipes are too small or not readily accessible for application of pipe markers, a brass identification tag at least 1 ½ inches in diameter, with depressed ½ inch high black letters and numerals, shall be securely fastened at locations specified for pipe markers.

D. See pipe marker schedule for size requirements of pipe markers.

2.04 MECHANICAL EQUIPMENT MARKERS

A. Identify all mechanical equipment, bare or insulated, installed in the rooms or on the roof, by means of lettered and numbered nameplate (not stenciled) identifying the equipment and service. Refer to the Drawings for equipment identifications. Nameplates shall be aluminum with permanent 1 ½ inch high white letters on a black background, mechanically affixed and installed in a readily visible location on the equipment. Coordinate the final equipment designation with the Owner.

B. In addition to markers, all mechanical equipment shall be furnished with the manufacturer's identification plate showing the name of equipment, manufacturer's name and address, date of purchase, model number and performance data.

2.05 DUCT WORK IDENTIFICATION

A. Provide full air distribution system identification at each side of a wall penetration, in a mechanical room, at all changes in direction and at no more than 50 foot intervals. Provide arrows identifying direction of flow.

B. Fire damper or Smoke damper access points shall be permanently identified on the exterior by a label having letters not less than 0.5 inch in height reading: SMOKE DAMPER or FIRE DAMPER.

C. Identification shall be preprinted labels.

D. Letter Size: 1-1/2 inches in height.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Apply piping system markers and valve tags in the following locations:
   1. Adjacent to each valve and fitting.
   2. At each branch location and riser take-off
   3. At each side of a pipe passage through floors, walls, ceiling and partitions.
   4. At each pipe passage to and from underground areas.
   5. Every 20 feet on all horizontal and vertical pipe runs.

B. Provide arrow markers showing direction of flow incorporated into or adjacent to each piping system marker. Use double-headed arrows if flow is in both directions.

C. Apply all piping system markers where view is unobstructed; markers and legends shall be clearly visible from operating positions.

D. Apply all tags and piping system markers in accordance with the manufacturer's instructions. Do not attach tags to valve handle such that the normal or emergency operation of the valve will be hindered.

3.02 VALVE CHART

A. Provide valve chart identifying each valve's number, size of valve and service.

B. Frame the chart and locate the schedule in the Mechanical Equipment Room. (Aluminum Frame with plastic window).

C. Provide a digital file that has the valve chart schedule in a spreadsheet (Excel) or document (PDF) format.

3.03 LAY IN CEILING TILES AND ACCESS DOORS

A. Provide a lettered and numbered nameplate for each access door indicating the mechanical equipment that the door provides access to.

B. Where VAV boxes, hot water reheat coils, or other mechanical devices are installed above a lay-in ceiling tile system, provide and install color coded thumb tabs to mark the location of the equipment above the ceiling.

3.04 SCHEDULES

A. Pipe Marker Letter Size Schedule:

Outside diameter of insulation or pipe Inches	**Letter height Inches**	**Color field Inches**
3/4 to 1-1/4	1/2	8
1-1/2 to 2	3/4	8
2-1/2 to 6	1 - 1/4	12
8 to 10	2 - 1/2	24
Over 10	3 - 1/2	24

+ + END OF SECTION + +

SECTION 15082

PIPE INSULATION FOR HVAC SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This section describes the insulation, jackets and accessories for HVAC piping as scheduled in Part 3 of this Section and as shown on the Drawings.

1.02 RELATED REQUIREMENTS

A. Section 07843 - Firestopping for Through Penetrations

B. Section 15122 - Non Fire Rated Sleeves and Seals

C. Section 15180 - Pipe, Valves, and Fittings for HVAC Systems

D. Section 15186 - Refrigerant Piping

1.03 REFERENCES

A. National Fire Protection Association (NFPA):
   1. NFPA 255 - Surface Burning Characteristics of Building Materials.

B. New York:
   1. Mechanical Code of New York State - 2020
   2. Energy Conservation Construction Code - 2020
   3. ASHRAE 90.1 - 2016

C. Greenguard

D. Underwriters Laboratories, Inc. (UL):
   1. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

E. American Society for Testing and Materials (ASTM):
   1. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   3. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C335 - Standard Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
6. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
7. ASTM C518 - Standard Test Method for Steady-State Heat Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
8. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
9. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
10. ASTM C547 - Standard Specification for Mineral Fiber Preformed Pipe Insulation.
11. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation
12. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
13. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
14. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing.
15. ASTM C 591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
16. ASTM C 610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.
17. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
18. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
19. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
20. ASTM D1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
21. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.
22. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
23. ASTM E96 - Standard Test Method for Water Vapor Transmission of Materials.

1.04 DEFINITIONS

A. Greenguard: Greenguard Environmental Institute

B. IAQ: Indoor Air Quality

C. EPA: Environmental Protection Agency.

D. WHO: World Health Organization

E. ASJ: All Service Jacket

F. SSL: Self-Sealing Lap

G. FSK: Foil-Scrim-Kraft; jacketing

H. PSK: Poly-Scrim-Kraft; jacketing

I. PVC: Polyvinyl Chloride

J. FRP: Fiberglass Reinforced Plastic

K. Cold Service Piping/ Surfaces: Pipes or surfaces where the normal operating temperature is 60 degrees F or lower.

L. Hot Service Piping/ Surfaces: Pipes or surfaces where the normal operating temperature is 105 degrees F or higher.

1.05 SUBMITTALS

A. Product data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Company specializing in manufacturing products specified with minimum 3 years documented experience.
   2. Installer: Company specializing in performing the Work of this Section with minimum 3 years documented experience.

B. Materials:
   1. Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255 and UL 723.
   2. Insulation for duct, pipe and equipment for above grade exposed to weather outside building shall be certified as being self-extinguishing for 1" thickness in less than 53 seconds when tested in accordance with ASTM D1692.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

B. Follow manufacturer's recommended storage and handling practices.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of each product (tapes, adhesives, mastics, cements, insulation, etc.).

B. Maintain temperature before, during, and after installation for a minimum of 24 hours.

C. Supply fiberglass products that assure excellent IAQ (Indoor Air Quality) performance through Greenguard Certification.

D. Mold: Carefully inspect any insulation that has been exposed to water. If it shows any sign of mold growth remove it from the Site. If the material is wet but shows no sign of mold, dry rapidly and thoroughly. If it shows signs of facing degradation from wetting remove it from the Site.

PART 2 - PRODUCTS

2.01 FIBER GLASS INSULATION

A. Approved Manufacturers:
   1. Knauf Insulation
   2. Johns Manville Corporation
   3. Owens Corning Corporation
   4. CertainTeed Corporation

B. Fiber glass insulation meeting ASTM C547, ASTM C585, and ASTM C795; rigid molded, noncombustible.

C. Factory applied vapor barrier jacket: ASJ/SSL conforming to ASTM C1136 Type I and ASTM E96, secured with self-sealing longitudinal laps and butt strips.

2.02 FIBER GLASS INSULATION JACKETS AND ACCESSORIES

A. Field-Applied Jackets and Fitting Covers
   1. PVC - 25/50 or Indoor/Outdoor, UV-resistant fittings, jacketing and accessories, white or colored. Fitting cover system consisting of pre-molded, high-impact PVC materials with fiber glass inserts. Approved Manufacturer: Proto Corporation.
      a. Thickness: 10 mil.
      b. Closures: stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.
   2. ASTM B209 formed aluminum, 0.016-inch thick in smooth, corrugated, or embossed finish with factory-applied moisture barrier. Approved Manufacturer: Childers.
      a. Overlap: 2-inch minimum.
      b. Fittings: 0.016-inch thick die-shaped with factory-applied moisture barrier.
      c. Metal jacket bands: 3/8-inch wide, 0.015-inch thick aluminum or 0.010-inch thick stainless steel.

3. ASTM A666, Type 304 stainless Steel, 0.010-inch thick in smooth, corrugated, or embossed finish with factory-applied moisture barrier. Approved Manufacturer: Childers.
    a. Overlap: 2-inch minimum.
    b. Fittings: 0.016-inch thick die-shaped with factory-applied moisture barrier.
    c. Metal jacket bands: 3/8-inch wide, 0.010-inch thick stainless steel.
4. Laminated Self-Adhesive Water and Weather Seals - Permanent acrylic self-adhesive System; weather resistant, high puncture and tear resistance; meeting or exceeding requirements of UL 723; applied in strict accordance with manufacturers' recommendations.

B. Fitting Insulation
1. Pre-formed fiberglass, preformed perlite, mitered fiberglass, mitered perlite or calcium silicate in lieu of PVC systems. Protect fittings with field-applied fitting covers.

C. Tapes
1. Vapor barrier type, self-sealing, non-corrosive, fire-retardant. Approved Manufacturer: Compac Corporation

2.03 ELASTOMERIC INSULATION

A. Approved Manufacturers:
1. Armacell LLC
2. K-Flex USA, Inc.
3. Approved equal

B. Flexible, tubular (Type 1) or sheet/roll form (Type 2) closed-cell elastomeric insulation complying with ASTM C534, Grade 1 - Standard (temperature range(-)297°F to 220°F; use molded tubular material wherever possible.

2.04 ELASTOMERIC INSULATION ACCESSORIES

A. Adhesives:
1. Air dried, waterproof vapor barrier contact adhesive, compatible with insulation for joining of seams and butt joints.

B. Finishes:
1. Provide a weather and UV resistant protective finish for outdoor applications in accordance with the manufacturer's recommendations.

2.05 CELLULAR GLASS INSULATION

A. Approved Manufacturers:
1. Pittsburgh Corning Corporation
2. Approved equal

B. Cellular glass insulation meeting ASTM C552, Type II.

2.06 CELLULAR GLASS INSULATION ACCESSORIES

A. Field-Applied Jackets and Fitting Covers:
   1. ASTM B209 formed aluminum, 0.016-inch thick in smooth, corrugated, or embossed finish with factory-applied moisture barrier. Approved Manufacturer: Childers or approved equal.
      a. Overlap: 2-inch minimum.
      b. Fittings: 0.016-inch thick die-shaped with factory-applied moisture barrier.
      c. Metal jacket bands: 3/8-inch wide, 0.015-inch thick aluminum or 0.010-inch thick stainless steel.
   2. ASTM A666, Type 304 stainless Steel, 0.010-inch thick in smooth, corrugated, or embossed finish with factory-applied moisture barrier. Approved Manufacturer: Childers or approved equal.
      a. Overlap: 2-inch minimum.
      b. Fittings: 0.016-inch thick die-shaped with factory-applied moisture barrier.
      c. Metal jacket bands: 3/8-inch wide, 0.010-inch thick stainless steel.
   3. Laminate: Factory applied vapor retarder jacket: ASJ/SSL conforming to ASTM C 1136 Type I, secured with self-sealing longitudinal laps and butt strips.

B. Adhesives:
   1. Two component adhesive for adhering cellular glass insulation to itself or to other porous or nonporous substrates. Approved products: PC 88 Adhesive by Pittsburgh-Corning or approved equal.

C. Joint Sealants:
   1. Styrene butadiene rubber sealant, stainless steel compatible. Approved products: Pittseal 727 Sealant by Pittsburgh-Corning or approved equal.

D. Coatings:
   1. Vapor and weather barrier acrylic latex coating. Approved products: Pittecote 404 Coating by Pittsburgh-Corning or approved equal.
   2. Vapor and weather barrier asphalt coating. Approved Products: Pittecote 300 Coating by Pittsburgh-Corning or approved equal.

2.07 HIGH DENSITY JACKETED INSULATION INSERTS FOR HANGERS AND SUPPORTS

A. For use with Fiberglass Insulation:
   1. Cold Service Piping:
      a. Polyurethane Foam: Minimum density 4 pcf, K of 0.13 at 75 degrees F, minimum compressive strength of 125 psi.
   2. Hot Service Piping:
      a. Calcium Silicate: Minimum density 15 pcf, K of 0.50 at 300 degrees F; ASTM C 533.
      b. Perlite: Minimum density 12 pcf, K of 0.60 at 300 degrees F; ASTM C 610.

B. For Use with Flexible Elastomeric Foam Insulation:

1. Provide to prevent thermal bridging and formation of condensation.
    a. Provide insulated piping supports at clamping points to prevent crushing and cross section area reduction of insulation.
    b. Load bearing PET or closed cell EPDM core.
    c. UV degradation resistant exterior
    d. Outside diameter shall match insulation sizes
    e. Armacell ArmaFix EcoLight, Aeroflex Arefix, or equal

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that all piping is tested and approved prior to insulation installation.

B. Verify that all surfaces are clean, dry and without foreign material before applying insulation materials.

3.02 INSTALLATION (GENERAL)

A. Install all materials using skilled labor regularly engaged in this type of work. Install all materials in strict accordance with manufacturer's recommendations, building codes, and industry standards.

B. Locate insulation and cover seams in the least visible location. Extend all surface finishes in such a manner as to protect all raw edges, ends and surfaces of insulation.

C. On cold surfaces where a vapor retarder must be maintained, apply insulation with a continuous, unbroken moisture and vapor seal. Insulate and vapor seal all hangers, supports, anchors, or other projections secured to cold surfaces to prevent condensation.

D. Insulated pipes conveying fluids below ambient temperature; insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. For hot piping conveying fluids 140°F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

F. For hot piping conveying fluids over 140°F, insulate flanges and unions at equipment.

G. Maintain continuous pipe insulation through walls, ceiling or floor openings, or sleeves except where firestop or firesafing materials are required.

H. Install insulation neatly, accurately and without voids, in accordance with manufacturer's instructions and NIAC National Commercial and Industrial Insulation Standards.

I. Insulate fittings, valves and flanges using premolded covers with precut insulation inserts.

J. Insulate piping using insulation of type and thickness scheduled in this Section.

K. Install metal shields between hangers or supports and the piping insulation. Install rigid insulation inserts as required between the pipe and the insulation shields. Fabricate inserts to be of equal thickness to the adjacent insulation and vapor seal as required. Insulation inserts shall be no less than the following lengths:

1½" to 2½" IPS	10" long
3" to 6" IPS	12" long
8" to 10" IPS	16" long
12" and over IPS	22" long

L. Pipe exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor) to be finished with PVC jacket and fitting covers, aluminum jacket, or stainless steel jacket.

M. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with stainless steel jacket with seams located on bottom side of horizontal piping. Coordinate insulation installation with heat-tracing installation and testing. Insulate piping after tracing or heat distribution tape has been installed and tested for continuity.

3.03 INSTALLATION (FIBER GLASS)

A. Provide a continuous vapor retarder on piping operating below ambient temperatures. Seal all joints, seams and fittings.

B. Firmly butt and secure ends with appropriate butt-strip material. On high-temperature piping, double layering with staggered joints when recommended by the insulation manufacturer. When double layering, the inner layer should not be jacketed.

C. Insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

D. Insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

E. Exterior Applications:
   1. Jacket piping and fittings exposed to the elements using aluminum or stainless steel jackets with a factory applied moisture barrier. Hold firmly in place with a friction type Z lock or a minimum 2" overlap joint. Seal all joints completely along the longitudinal seam and install so as to shed water. Seal all circumferential joints by use of preformed butt strips; minimum 2" wide or a minimum 2" overlap. Overlap butt strips to the adjacent jacketing a minimum ½-inch and completely weather seal. Install a 6" to 10" unsealed slide joint every 25 to 30 lineal feet to allow for the thermal expansion of the pipe and jacketing. In addition, apply a thin bead of silicone grease in the overlap to prevent water migration while allowing the joint to slide. Install an unsealed slide joint where distance between fittings exceeds 8 lineal feet.
   2. Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness ad adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum or stainless steel jacket with seams located on bottom side of horizontal piping.

F. Cold Piping Insulation:
   1. On below freezing applications and in high abuse areas protect the ASJ jacket with a PVC vapor retarding outer jacket. Seal exposed ends of the insulation with a vapor retarder mastic installed per the manufacturer's recommendations. Apply vapor seals at butt joints at every fourth pipe section joint and at each fitting to isolate any water incursion.
   2. On chilled water systems operating in conditions of: RH of 90% and above, follow the same guidelines as described above for below freezing applications.

3.04 INSTALLATION (ELASTOMERIC)

A. Piping:
   1. Install pipe insulation by slitting tubular sections and applying onto piping or tubing. Alternately, slide unslit sections over the open ends of piping or tubing. Adhere and seal all seams and butt joints using adhesive.
   2. Push insulation onto the pipe, never pull. Stretching of insulation may result in open seams and joints.
   3. Tape the ends of the tubing before slipping the insulation over the new pipes to prevent dust from entering the pipe.
   4. Clean cut all edges. Do not leave rough or jagged edges of the insulation. Use proper tools such as sharp non-serrated knives.
   5. On cold piping, adhere insulation directly to the piping at the high end of the run using a two-inch strip of adhesive on the inner diameter of the insulation and on the pipe. Coat all exposed end cuts of the insulation with adhesive. Adhere all penetrations through the insulation and termination to the substrate to prevent condensation migration.
   6. Use sheet insulation on all pipes larger than 6-inch diameter. Do not stretch insulation around the pipe. On pipes larger than 12-inch diameter, adhere insulation directly to the pipe on the lower 1/3 of the pipe. On pipes greater than 24-inch diameter, completely adhere insulation.

7. Stagger seams when applying multiple layers of insulation.

B. Valves, Flanges and Fittings:
   1. Insulate all fittings with the same insulation thickness as the adjacent piping. Adhere all seams and mitered joints with adhesive. Sleeve screwed fittings and adhere with a minimum 1" overlap onto the adjacent insulation.
   2. Insulate valves, flanges, strainers, and Victaulic couplings using donuts covered with sheet or oversized tubular insulation.

C. Hangers:
   1. Support piping system using high density inserts with sufficient compressive strength. Apply elastomeric foam insulation with the same or greater thickness than the pipe insulation to pipe supports. Seal all joints with adhesive.
   2. Standard and split hangers - Insulate piping supported by ring hangers with the same insulation thickness as the adjacent pipe. Seal all seams and butt joints with adhesive. Sleeve ring hangers using oversized tubular insulation. On cold piping, extend insulation up the hanger rod a distance equal to four times the insulation thickness. Insulation tape may be used to a thickness equal to the adjacent insulation thickness.
   3. Clevis hangers or other pipe support systems - Install saddles under all insulated lines at unistrut clamps, clevis hangers, or locations where insulation may be compressed due to the weight of the pipe. Insert and adhere wooden dowels or blocks of a thickness equal to the insulation to the insulation between the pipe and the saddle.
   4. Pre-insulated pipe hangers can be used to prevent compression of insulation at standard split, clevis hangers or other pipe support systems. Adhere a pair of non-skid pads to the clamps to minimize the movement. In addition, to prevent loosening of the clamps, use an antivibratory fastener, such as a nylon-locking nut.

D. Exterior Applications:
   1. Paint all outdoor exposed piping with two coats of UV resistant finish. Prior to applying the finish, wipe the insulation with denatured alcohol. Do not tint the finish.
   2. Locate seams for all outdoor exposed piping on the lower half of the pipe.

3.05 INSTALLATION (CELLULAR GLASS)

A. Apply cellular glass insulation in a single layer where thickness permits. Seal joints with joint sealant. Secure inner layers of insulation with fiber-reinforced tape. Secure the outermost layer of insulation with metal bands of appropriate width and thickness, two bands per insulation section.
   1. Finish:
      a. Outdoor Applications - field applied metal jacket.
      b. Indoor Applications - factory applied ASJ.

B. Consult the manufacturer's installation instructions for additional information.

C. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness ad adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with stainless steel jacket with seams located on bottom side of horizontal piping.

3.06 PIPING INSULATION MATERIAL SCHEDULE

SYSTEM OR SERVICE	LOCATION	INSULATION TYPE	JACKET
HEATING HOT WATER	INSIDE	FIBER GLASS	ALL SERVICE JACKET
HEATING HOT WATER	OUTSIDE	FIBER GLASS	ALUMINUM JACKET
CONDENSER WATER	INSIDE	CELLULAR GLASS	ALL SERVICE JACKET
CONDENSER WATER	OUTSIDE	CELLULAR GLASS	ALUMINUM JACKET
CONDENSATE DRAINS	INSIDE	ELASTOMERIC	
HVAC REFRIGERANT LINES	INSIDE	ELASTOMERIC	
HVAC REFRIGERANT LINES	OUTSIDE	ELASTOMERIC	EXTERIOR COATING

3.07 MINIMUM PIPING INSULATION THICKNESS (IN.)

FLUID OPERATING	SYSTEMS IN TEMP.	INSULATION CONDUCTIVITY	NOMINAL PIPE OR TUBE SIZE (IN.)

TEMP. RANGE (°F)	RANGE (°F)	CONDUC-TIVITY BTU*IN./ (H*SQ. FT.*°F)	MEAN RATING TEMP (°F)	<1	1 TO < 1-1/2	1-1/2 TO < 4	4 TO < 8	≥8
> 350		0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350		0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
201-250		0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	HWS&R, REFR	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	CWR (FROM BLOWERS BACK TO BUFFER TANK), CWS&R (OUTDOORS)	0.21-0.28	100	1.0	1.0	1.5	1.5	1.5
40-60	COND, CWR (FROM WTWHP'S BACK TO BUFFER TANK)	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
< 40		0.20-0.26	50	0.5	1.0	1.0	1.0	1.5

+ + END OF SECTION + +

SECTION 15083

DUCTWORK INSULATION FOR HVAC SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This section describes the insulation, jackets and insulating accessories for sheet metal HVAC ductwork as scheduled in Part 3 of this Section and as shown on the Drawings.

1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. NFPA 255 - Surface Burning Characteristics of Building Materials.

B. New York:
   1. Mechanical Code of New York State - 2020
   2. Energy Conservation Construction Code of New York State - 2020

C. Greenguard

D. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

E. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

F. Underwriters Laboratories, Inc. (UL):
   1. UL 723 - Surface Burning Characteristics of Building Materials.

G. American Society for Testing and Materials (ASTM):
   1. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
   2. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   3. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   4. ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
   5. ASTM C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
   6. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
   7. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
   8. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
   9. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
   10. ASTM E84 - Surface Burning Characteristics of Building Materials.

11. ASTM E96 - Water Vapor Transmission of Materials.

1.03 DEFINITIONS

A. Greenguard: Greenguard Environmental Institute

B. IAQ: Indoor Air Quality

C. EPA: Environmental Protection Agency

D. WHO: World Health Organization

E. ASJ: All Service Jacket

F. SSL: Self-Sealing Lap

G. FSK: Foil-Scrim-Kraft; jacketing

H. PSK: Poly-Scrim-Kraft; jacketing

I. PVC: Polyvinyl Chloride

J. FRP: Fiberglass Reinforced Plastic

K. Cold Piping/Ductwork/Surfaces: Pipes or surfaces where the normal operating temperature is 60 degrees F or lower.

1.04 SUBMITTALS

A. Product data: To include product description, manufacturer's installation instructions, types and recommended thicknesses for each application, and location of materials.

B. Provide samples and mock-ups of systems as required.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of tapes, adhesives, mastics, cements, and insulation materials.

B. Follow manufacturer’s recommended handling practices.

C. Supply fiberglass products that assure excellent IAQ (Indoor Air Quality) performance through Greenguard Certification.

D. Mold: Carefully inspect any insulation that has been exposed to water. If it shows any sign of mold growth remove it from the Site. If the material is wet but shows no sign of mold, dry rapidly and thoroughly. If it shows signs of facing degradation from wetting remove it from the Site. Discard air handling insulation used in the air stream if exposed to water.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Company specializing in manufacturing Products specified with minimum 3 years documented experience.
   2. Installer: Company specializing in performing the Work of this Section with minimum 3 years documented experience.

B. Materials:
   1. Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255 and UL 723.
   2. Certify insulation for duct, pipe and equipment for above grade exposed to weather outside building as being self-extinguishing for 1" thickness in less than 53 seconds when tested in accordance with ASTM D1692.

PART 2 - PRODUCTS

2.01 FIBERGLASS DUCT WRAP

A. Flexible Fiber Glass Blanket meeting ASTM C553 Types I, II and III, and ASTM C1290; Greenguard compliant.

B. Factory Applied Vapor Retarder Jacket: FSK or PSK conforming to ASTM C1136 Type II.

C. Maximum service temperature of 250º F (Faced) or 350° F (Unfaced).

D. Density:
   1. Concealed areas: Minimum 0.75 PCF.
   2. Exposed areas: Minimum 1.0 PCF.

E. Approved Products:
   1. Friendly Feel Duct Wrap by Knauf

2.02 FIBERGLASS RIGID BOARD

A. Rigid Fiber Glass Board insulation meeting ASTM C612 Type IA and IB.

B. Mean temperature by ASTM C177 and a maximum service temperature of 450º F.

C. Factory Applied Vapor Retarder Jacket: ASJ conforming to ASTM C1136 Type I, or FSK or PSK conforming to ASTM C1136 Type II.

D. Density:
   1. Concealed areas: Minimum 3 PCF
   2. Exposed areas: Minimum 6 PCF

E. Approved Products:
   1. Insulation Board by Knauf

2.03 ACOUSTIC DUCT LINER

A. Conforming to ASTM C1071 Type 1 and NFPA 90A & 90B.

B. Noise Reduction Coefficient (NRC): ASTM C423 Type A Mounting, 0.40 or higher for ½" product, 0.60 or higher for 1" product.

C. Rated for a maximum air velocity of 6000 Feet per minute.

D. Approved Products:
   1. Textile Duct Liner with HydroshieldÔ Technology by Knauf.

2.04 FIBERGLASS INSULATION ACCESSORIES

A. Aluminum Jacket - 0.016-inch (0.406 mm) thick in smooth, corrugated, or embossed finish with factory applied moisture barrier. Overlap 2-inch (50 mm) minimum.

B. Laminated Self-Adhesive Water and Weather Seals - apply per manufacturers' recommendations.

C. Tapes - Vapor barrier type, self-sealing, non-corrosive, fire-retardant. Approved Manufacturer: Compac Corporation or approved equal.

D. Adhesives - Approved Manufacturer: Foster or approved equal.

E. Mastic - Approved Manufacturer: Foster or approved equal.

F. Vapor Barrier Coating - Approved Manufacturer: Foster or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that all ductwork is tested and approved prior to insulation installation.

B. Verify that all surfaces are clean, dry and without foreign material before applying insulation materials.

3.02 DUCTWORK REQUIRING INSULATION

A. Insulate Ductwork as specified in the DUCTWORK INSULATION SCHEDULE.
   1. Insulate any additional ductwork or plenums indicated to be insulated on the Drawings.

3.03 INSTALLATION (GENERAL)

A. Install all materials using skilled labor regularly engaged in this type of work. Install all materials in strict accordance with manufacturer's recommendations, building codes, and industry standards.

B. Locate insulation and cover seams in the least visible location. Extend all surface finishes in such a manner as to protect all raw edges, ends and surfaces of insulation.

C. On cold surfaces where a vapor retarder must be maintained, apply insulation with a continuous, unbroken moisture and vapor seal. Insulate and vapor seal all hangers, supports, anchors, or other projections secured to cold surfaces to prevent condensation.

D. Install insulation neatly, accurately and without voids, in accordance with manufacturer's instructions and NIAC National Commercial and Industrial Insulation Standards.

E. Install ductwork hanger supports on the outside of the insulation. Where vertical ducts are supported to the building structure, insulate the ductwork supports to prevent condensation.

F. Insulate ductwork using insulation of the type and thickness scheduled at the end of this Section.

G. If specified insulation board thickness does not cover ductwork standing seams and reinforcing angles, insulate them by adhering a grooved strip of fiberglass board with a thickness at least 1 ½ inches greater than the height of the seam or angle covered over the standing seam or angle.

3.04 ACOUSTIC DUCT LINER

A. Apply Duct Lining in strict accordance with the latest edition of SMACNA's "HVAC Duct Construction Standard Metal & Flexible" and NAIMA's "Fibrous Glass Duct Liner Standard".

B. Select length of mechanical fasteners in accordance with the manufacturer's recommendation as listed on each product. Install mechanical fasteners perpendicular to the duct surface, and such that the pin does not compress the liner more than 1/8 inch relative to the nominal thickness of the insulation.

C. Adhesive shall conform to ASTM C916. Apply adhesive to the sheet metal with a 90% minimum coverage. Coat all exposed edges of the duct liner with the same adhesive. Repair all rips and tears using an adhesive that conforms to ASTM C916.

D. Cover all internal duct areas with duct liner. Firmly butt transverse joints with no gaps and coat with adhesive. Overlap and compress longitudinal corner joints.

E. When air velocities are 4000 to 6000 FPM, apply metal nosing to all upstream transverse edges to additionally secure the insulation.

3.05 FIBERGLASS WRAP INSULATION

A. Apply external duct wrap per insulation schedule even where internally lined.

B. Install Duct Wrap to obtain specified R-value using a maximum compression of 25%.

C. Firmly butt all joints.

D. Overlap the longitudinal seam of the vapor retarder a minimum of 2 inches.

E. Where vapor retarder performance is required, repair all penetrations and damage to the facing using pressure-sensitive foil tape or mastic prior to system startup.

F. Use pressure-sensitive foil tapes a minimum 3 inches wide and apply by moving pressure using a squeegee or other appropriate sealing tool.

G. Additionally secure Duct Wrap to the bottom of rectangular ductwork over 24 inches wide using mechanical fasteners on 18-inch centers. Do not over-compress insulation during installation.

H. Overlap unfaced Duct Wrap a minimum of 2 inches and fasten using 4-inch to 6-inch nails or skewers spaced 4 inches apart, or secured with a wire/banding system. Do not damage the Duct Wrap.

3.06 FIBERGLASS BOARD INSULATION

A. Fit insulation by scoring, cutting and mitering to fit the contour of the ductwork.

B. Attach insulation to ductwork in thickness scheduled by brushing adhesive uniformly on all sides of ductwork covering 100 percent of ductwork surface. Press insulation into place, making complete contact with adhesive. Butt edges of insulation board tightly together without gaps.

C. Additionally, hold insulation in place by impaling on pins welded to all four sides of the ductwork. Locate and weld pins a minimum 12 inch on center with a minimum of 2 rows per side of duct and no less than 3 inches from the edges of the ductwork. Secure insulation to pins with 1 inch diameter hold-down washers. As an alternate to welded pins, provide “Gripnail” mechanical surface fasteners by Gripnail Corporation using pneumatic hammer designed for this work.

D. Seal all joints, seams, breaks, and punctures in facing with adhesive and cover with 3 inch wide sealing tape. Flash supports with vapor barrier coating.

E. For rectangular ducts and plenums exposed to weather, pitch ductwork or insulation board minimum ¼ inch per foot to prevent rainwater from accumulating on top of duct or plenum. Cover insulation board with Sheet Waterproofing Membrane.

3.07 DUCTWORK INSULATION SCHEDULE

A. Fiber Glass Insulation Schedule:

Ductwork System	Type	Minimum R-Value
Supply Ducts and Plenums, Concealed	Fiberglass Duct Wrap	6
Return Ducts and Plenums, Concealed	Fiberglass Duct Wrap	6

Supply and Return Ducts and Plenums, Exposed in the Space Served	Uninsulated	NA
Supply and Return Ducts and Plenums, Exposed Other Than in the Space Served	Fiberglass Rigid Board	6
Outdoor Air Intake Ducts, Indoors	Fiberglass Rigid Board	6
Unused Portions of Louvers	Louver Blank Off Panels	As Specified
Ductwork Upstream and Downstream of Air Handling Units and Supply and Return Fans, Located Indoors	Internal Acoustic Duct Lining	Note 1, 2
Catwalk Exhaust Ducts from Fan (EF-1 thru EF-5) to Louver	2-inch Internal Acoustic Duct Lining	NA

Notes:

1. Ductwork shall be provided with 1-inch internal acoustic lining in addition to externally applied insulation in accordance with the table above.
2. Unless noted otherwise on drawings, duct liner shall be continuous, extending from air handling unit/fan sections out for a linear distance of 20'.

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SECTION 15100

PROCESS AND CIVIL VALVES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install valves and appurtenances, complete and operational.

   2. Valves specifically excluded from this Section include valves for plumbing work, heating and ventilation work, those for fuel oil piping, chlorine gas valves, and any and all valves specifically included with equipment.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before process valves work.

C. Related Sections:
   1. Section 02200, Earthwork.
   2. Section 03300, Cast-in-Place Concrete.
   3. Section 05051, Anchor Systems.
   4. Section 09900, Painting.
   5. Section 15051, Buried Piping Installation.
   6. Section 15052, Exposed Piping Installation.
   7. Section 15061, Ductile Iron Pipe.
   8. Section 15410, Domestic Water Piping.

D. The following index of this Section is included for convenience:

Part 1 - General
1.1 Description
1.2 References
1.3 Quality Assurance
1.4 Submittals
1.5 Delivery, Storage and Handling

Part 2 - Products
2.1 General
2.2 Valve Boxes
2.3 Resilient-Seated Gate Valves
2.4 Resilient-Seated Knife Gate Valves
2.5 Eccentric Plug Valves (Four Inches and Larger)
2.6 Eccentric Plug Valves (Smaller than Four Inches)
2.7 Stainless Steel Ball Valves
2.8 PVC Ball Valves
2.9 Swing Check Valves
2.10 Pressure Reducing Valves
2.11 Mud Valves
2.12 Sewage Air Release Valves
2.13 Solenoid Valves

2.14 Balancing Valves
2.15 Fire Hydrants
2.16 Quick Disconnect Couplings
2.17 Sanitary Tank Hatch
2.18 Electric Actuators (Open/Close)
2.19 Electric Actuators (Open/Close, Devicenet)
2.20 Electric Actuators (Modulating)
2.21 Appurtenances for Metallic Valves
2.22 Anchorages and Mounting Hardware
2.23 Tools, Lubricants and Spare Parts
2.24 Painting of Exposed Valves, Hydrants and Appurtenances
2.25 Painting of Buried Valves and Hydrants
2.26 Inspection and Witness Shop Tests

Part 3 - Execution
3.1 Inspection
3.2 Installation
3.3 Field Quality Control
3.4 Manufacturer's Services
3.5 Supplements

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
1. AISI 1144, Carbon Steel, as Rolled.
2. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
3. ANSI B16.5, Pipe Flanges and Flanged Fittings.
4. ANSI/NSF 61 Drinking Water Components – Health Effects.
5. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
6. ASTM A380, Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.
7. ASTM A536, Specification for Ductile Iron Castings.
8. ASTM B98/B98M, Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
9. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron and Pressure Pipe and Fittings.
10. ASTM D429, Test Methods for Rubber Property - Adhesion to Rigid Substrates.
11. ASTM D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
12. AWWA C502 - Dry-Barrel Fire Hydrants
13. AWWA C501, Cast-Iron Sluice Gates.
14. AWWA C508, Swing-Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
15. AWWA C509, Resilient-Seated Gate Valves for Water-Supply Service.
16. AWWA C515 - Reduced Wall, Resilient-Seated Gate Valves for Water Supply Service.
17. AWWA C520, Knife Gate Valve, Sizes 2 In. Through 92 In.
18. AWWA C540, Power-Actuating Devices for Valve and Slide Gates.
19. AWWA C550, Protective Interior Coatings for Valves and Hydrants.
20. SSPC SP-6, Commercial Blast Cleaning.
21. SSPC SP-10, Near White Blast Cleaning.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
1. Manufacturer shall have minimum of five years of experience producing substantially similar materials and equipment to that required and be able to provide evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain each type of equipment and appurtenances included in this Section, regardless of the component manufacturer, from a single manufacturer of the type of process valve. For each type of valve, do not furnish valves of more than one manufacturer.
   2. Supplier of each type of equipment specified shall review and approve or prepare all Shop Drawings and other submittals for all components associated with the type of process valve Supplier is furnishing.
   3. Components shall be suitable for use in the specified service conditions. Components shall be integrated into the overall assembly by the manufacturer.

C. Design Criteria
   1. All valves and appurtenances shall be new and in perfect working condition. Valves shall be designed for continuous use with a minimum of maintenance and service required and shall perform the required function without exceeding the safe limits for stress, strain or vibration. In no case will used or damaged valves be acceptable.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings: Submit the following for Valves Four Inches and Larger:
      a. Installation drawings showing orientation of valve in both plan and elevation view. Drawings shall clearly identify valve and its appurtenances, including controls, actuators, valve stems, and other components. Show dimensions of valves and appurtenances in relation to piping and structural and architectural components, where applicable.
      b. Controls for and control characteristics of modulating valves.
      c. Power and control wiring diagrams, including terminals numbers for electric-motor actuators.
      d. Calculations for sizing of electric actuators.
      e. Calculations for sizing of operating mechanism with extension stems.
      f. Calculations for sizing of gear actuators.
   2. Product Data:
      a. Product data sheets.
      b. Complete catalog information, including dimensions, weight, specifications, and identification of materials of construction of all parts.
      c. Corrosion resistance information to confirm suitability of valve materials for the application. Furnish information on chemical resistance of elastomers from elastomer manufacturer.
      d. Cv values and hydraulic headloss curves (for Valves 4 Inches and Larger).
   3. Samples:
      a. If requested by Engineer, furnish one foot of chain for chainwheel-operated valves.
   4. Testing Plans: Submit plan for shop testing of each valve for which shop testing is specified, including testing plan's and test facility's limitations proposed.

B. Informational Submittals: Submit the following for Valves 4 Inches and Larger:
   1. Certificates:
      a. Certificates of compliance with referenced standards, where applicable, including those of AWWA, NSF, and others required by Engineer. For each valve specified to be manufactured and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests and certification of proper installation.
   2. Manufacturer Instructions: Submit manufacturer's instructions for handling, storing, and installing valves and appurtenances. Provide templates and setting drawings for valves and appurtenances that require anchor bolts or similar anchorages.
   4. Source Quality Control Submittals:

a. Submit four copies of shop test results and inspection data, certified by manufacturer.

5. Field Quality Control Submittals: Submit results of field tests required.
6. Supplier's Reports: When requested by Engineer, submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed and results obtained.
7. Qualifications Statements: When requested by Engineer, submit manufacturer's qualifications demonstrating compliance with the Specifications, including list of existing installations with contact names and telephone number(s) for each.

C. Closeout Submittals: Submit the following for Valves 4 Inches and Larger:
1. Operations and Maintenance Data:
a. Furnish operation and maintenance manuals in accordance with Section 017830, Operation and Maintenance Data.
b. Furnish complete nameplate data for each valve and electric actuator in operations and maintenance manuals.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
2. Inspect boxes, crates, and packages upon delivery to Site and notify Engineer in writing of loss or damage to materials and equipment. Promptly remedy loss and damage to new condition in accordance with manufacturer's instructions.

B. Furnish covers for all openings.
1. All valves 3-in and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.
2. All valves smaller than 3-in shall be shipped and stored as above except that heavy card board covers may be furnished instead of wood.

C. Storage and Protection:
1. Keep products off ground using pallets, platforms, or other supports. Store equipment in covered storage and prevent condensation and damage by extreme temperatures.
2. Store in accordance with manufacturer's recommendations. Protect steel, packaged materials, and electronics from corrosion and deterioration.
3. Store equipment to permit easy access for inspection and identification.
4. Any corrosion in evidence at the time of Owner acceptance shall be removed, or the valve shall be removed from the job.

PART 2 – PRODUCTS

2.1 GENERAL

A. Valves, General:
1. Provide each valve with manufacturer's name and rated pressure cast in raised letters on valve body.
2. Provide valves with Type 316 stainless steel nameplate attached with Type 316 stainless steel screws. Nameplates shall have engraved letters displaying the following minimum information:
a. Valve size.
b. Pressure and temperature ratings.

c. Application (other than water and wastewater).
d. Date of manufacture.
e. Manufacturer's name.

3. Provide valves to turn clockwise to close, unless otherwise specified.
4. Provide valves with permanent markings for direction to open.
5. Manually operated valves, with or without extension stems, shall require not more than 40-pound pull on manual operator to open or close valve against specified criteria. Gear actuator and valve components shall be able to withstand minimum pull of 200 pounds on manual operator and input torque of 300-foot pounds to actuator nut. Manual operators include handwheel, chainwheel, crank, lever, and T-handle wrench.
6. All buried valves shall open clockwise.

B. Valve Materials:
1. Valve materials shall be suitable for the associated valve's service or application, as shown.
2. Protect wetted parts from galvanic corrosion caused by contact of different metals.
3. Wetted components and wetted surfaces of valves used with potable water or water that will be treated to become potable shall conform to ANSI/NSF 61.
4. Clean and descale fabricated stainless steel items in accordance with ASTM A380 and the following:
a. Passivate all stainless steel welded fabricated items after manufacture by immersing in pickling solution of six percent nitric acid and three percent hydrofluoric acid. Temperature and detention time shall be sufficient for removing oxidation and ferrous contamination without etching surface. Perform complete neutralizing operation by immersing in trisodium phosphate rinse followed by clean water wash.
b. Scrub welds with same pickling solution or pickling paste and clean with stainless steel wire brushes or by grinding with non-metallic abrasive tools to remove weld discoloration, and then neutralize and wash clean.

C. Valve Joints:
1. Exposed Valves: Unless otherwise specified, provide with flanged ends conforming to ANSI B16.1. Pressure class of flanges shall be equal to or greater than specified pressure rating of the associated valve.
2. Buried Valves: Unless otherwise specified, provide with mechanical or push-on joints, restrained or unrestrained, as required by piping with which valve is installed.
3. For stainless steel bolting, except where nitrided nuts are required, use graphite-free anti-seize compound to prevent galling. Strength of joint shall not be affected by using anti-seize compound.

2.2 VALVE BOXES

A. All buried valves shall be provided with extension shafts, operating nuts and valve boxes as follows:
1. Top of the operating nut shall be located 6 in. below the rim of the valve box.
2. Valve boxes shall be the "Dwyer" style, with 8-3/8-in or 6-3/8-in cover, as manufactured by Bibby Ste. Croix of Hamilton, Ontario, Canada; Bingham & Taylor of Culpepper, Virginia; or equal and shall be a heavy-pattern cast iron, three-piece, telescoping type box with dome base suitable for installation on the buried valves.
3. Inside diameter shall be at least 4-1/2-in.
4. Barrel length shall be adapted to the depth of cover, with a lap of at least 6-in when in the most extended position.
5. Covers shall be cast iron with integrally-cast direction-to- open arrow. Aluminum or plastic are not acceptable. A means of lateral support for the valve extension shafts shall be provided in the top portion of the valve box.
3. The upper section of each box shall have a top flange of sufficient bearing area to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of

the valve and shall be oval.

4. An approved operating key or wrench shall be furnished.

2.3 RESILIENT-SEATED GATE VALVES

A. Valves 3-in through 30-in shall be manufactured in accordance with AWWA C509 and as specified herein. Valves shall be:
   1. The RS series resilient wedge gate valve (available in 3-in through 12-in) by M&H Valve Company of Anniston, Alabama;
   2. The Series 2360 resilient wedge gate valve (available in 2-in through 12-in) by Mueller Company of Decatur, Illinois;
   3. Or equal.

B. Alternatively, valves 3-in through 36-in shall be manufactured in accordance with AWWA C515 and as specified herein. Valves shall be:
   1. The RS series resilient wedge gate valve (available in 4-in through 36-in) by M&H Valve Company of Anniston, Alabama;
   2. The Series 2361 ductile iron resilient wedge gate valve (available in 14-in through 36-in) by Mueller Company of Decatur, Illinois;
   3. Or equal.

C. General:
   1. Type:
      a. For interior and exposed service, provide outside screw and yoke (OS&Y) rising-stem valves, unless otherwise specified.
      b. Provide position indicators for NRS valves used in exposed service.
   2. Minimum Rated Working Pressure: 200 psig.
   3. Maximum Fluid Temperature: 150 degrees F.
   4. Provide valves with fully encapsulated resilient wedges, unless otherwise specified.
   5. Valves should be provided with a minimum of two O-ring stem seals.
   6. Extension stems:
      a. Provide extension stems to bring operating nut to six inches below valve box cover.
      b. Materials of Stems and Stem Couplings: Type 316 stainless steel.
      c. Maximum Slenderness Ratio (L/R): 100
      d. Provide top nut and bottom coupling of ductile iron or cast-iron with pins and set screws of Type 316 stainless steel.
   7. Wrench Nuts:
      a. Provide wrench nuts on buried valves of nominal two-inch size.
      b. Arrow indicating direction of opening the valve shall be cast on the nut along with the word “OPEN”.
      c. Material: Ductile iron or cast-iron.
      d. Secure nut to stem by mechanical means.
   8. Valves shall be non-rising stem.
   9. Valves shall have mechanical joint ends compliant with AWWA C111 unless otherwise noted.

D. Materials of Construction: Shall conform to AWWA C509 and shall be as follows:
   1. Valve Body, Bonnet, and Stuffing Box: Cast-iron.
   2. Wedge: Cast-iron, symmetrically and fully encapsulated with molded rubber having minimum 1/8-inch thickness.
   3. Extension stems and stem couplings:
      a. Materials of Stems and Stem Couplings: Type 316 stainless steel.
      b. Pins and set screws: Type 316 stainless steel.
   4. Wrench nut: ductile iron or cast iron.
   5. Rubber Items: Buna-N or other synthetic rubber suitable for the application.

6. Internal and external bolting and other hardware including pins, set screws, plug, studs, bolts, nuts, and washers shall be Type 316 stainless steel.

E. Interior Coating:
1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be heat activated fusion bonded epoxy coated and comply with AWWA C550.

F. Testing:
1. Test valves in valve manufacturer's shop in accordance with AWWA C509.

2.4 RESILIENT-SEATED KNIFE GATE VALVES

A. Manufacturers: Provide products of one of the following:
1. DeZurik.
2. Rovalve.
3. Or equal.

B. General:
1. Provide valves conforming to AWWA C520 and as specified in this Section.
2. Minimum Rated Working Pressure: 150 psig.
3. Valve shall be suitable for horizontal installation and provide drip-tight, bi-directional shutoff at rated pressure. Line pressure against the gate shall not be required to achieve drip-tight seal.
4. Provide flat bottom gate with full perimeter seating against the seat. Seat shall be fully replaceable from the top of the valve.
5. Packing and packing gland shall be externally adjustable and accessible without disassembling valve or removing the actuator.
6. Stem nut shall be replaceable from the top of the yoke without removing the yoke.
7. Valve body shall be lug style, solid cast in one piece. End connections shall conform to ANSI B16.5.
8. Provide each valve with an electric motor actuator and remote-mounted control panel conforming to the requirements specified herein.
9. Valves and control panels shall be suitable for use in a Class I, Division 1 hazardous environment.

C. Materials of Construction:
1. Valve Body, Gate, Gland, Seat Ring, Retainer Seat and Retaining Ring: Type 316 Stainless Steel.
2. Seat and O-ring: Acrylonitrile-butadiene (NBR)
3. Stem and Yoke: Type 304 Stainless Steel.
4. Packing: Teflon.
5. Internal and external bolting and other hardware, including pins, set screws, studs, bolts, nuts, and washers, shall be Type 316 stainless steel.

D. Testing:
1. Test valves in manufacturer's shop in accordance with AWWA C520.

2.5 ECCENTRIC PLUG VALVES (FOUR INCHES AND LARGER)

A. Manufacturers: Provide products of one of the following:
1. DeZurik.
2. Clow Valve Company (a division of McWane).
3. Or equal.

B. General:
   1. Provide eccentric-type plug valves each with rectangular ports conforming to AWWA C517 and as specified in this Section.
   2. Sizes: Four-inch diameter and larger.
   3. Minimum Rated Working Pressure: 175 psig.
   4. Maximum Fluid Temperature: 180 degrees F.
   5. Minimum Port Area:
      a. Valves 20-inch Diameter and Smaller: 80 percent of nominal pipe area.
      b. All plug valves used for grit applications shall be full port 100 percent of nominal pipe area.
   6. Packing and packing gland shall be externally adjustable and accessible without disassembling valve and without removing the actuator.
   7. Valves shall provide drip-tight, one-directional shutoff at rated pressures.
   8. Plug shall have cylindrical seating surface eccentrically offset from center of plug shaft. Interface between plug face and body seat, with plug in closed position, shall be externally adjustable in the field with valve in the line while under pressure.
   9. Plug shall be supported to top bearing by using spring that is externally adjustable.
   10. All plug valves shall allow pigging of the piping with line-size pigs.

C. Materials of Construction:
   1. Body: Cast Iron ASTM A126 Class B, or Ductile-iron ASTM A536 Grade 65-45-12.
      a. Valves shall be coated inside. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be epoxy-coated in accordance with AWWA C550.
   2. Plug:
      a. Core shall be one piece with integral shafts: Cast Iron ASTM A126 Class B, or Ductile-iron, ASTM A536 Grade 65-45-12.
      b. Plug Facing: Neoprene or Buna-N.
      c. For valves up to eight-inch diameter, plugs shall be fully encapsulated with rubber. For valves larger than eight-inch diameter, provide plugs with rubber facing. Minimum thickness of rubber lining shall be 1/8-inch. Rubber hardness shall be a minimum of 70 (Shore A) durometer. Rubber-to-metal bond shall withstand minimum 75-pound pull conforming to ASTM D429 Method B.
   3. Seats: Minimum 1/8-inch welded overlay of minimum 90 percent pure nickel on surfaces contacting plug face. Seats shall provide contact area of at least 1/2-inch width all around.
   4. Stem Bearings: Sintered, oil impregnated, permanently lubricated of Type 316 stainless steel.
   5. Stem Seal: Multiple neoprene V-ring type.
   6. All internal and external bolting and other hardware including pins, set screws, plug, studs, bolts, nuts and washers shall be Type 316 stainless steel.

D. Shop Testing:
   1. Operational Tests:
      a. To demonstrate that complete assembly is workable, successfully operate each valve (with actuator mounted directly on valve) three times from fully closed to fully open position and reverse under no-flow condition.
   2. Leakage Tests:
      a. Test each valve for leaks while valve is in closed position.
      b. Test valves at rated pressures. During test, valves shall be drip-tight. Test duration shall be at least five minutes for valves up to 20-inch diameter and ten minutes for valves larger than 20-inch diameter. Tests shall be repeated successfully with pressure in the unseating direction.
   3. Hydrostatic Test: Test valves to an internal hydrostatic pressure equivalent to twice rated pressure of valve. During hydrostatic test, there shall be no leakage through metal, end joints, and shaft seal, nor shall any part be permanently deformed. Duration of hydrostatic test shall be sufficient to allow visual examination for leakage. Test duration shall be at

least one minute for valves eight-inch diameter and smaller, three minutes for valves 10-inch through 20-inch diameter, and ten minutes for valves 24-inch diameter and larger.

E. Gear Actuators for Manually-operated Valves:
1. Provide gear actuators on buried and exposed valves, except valves four-inch diameter and smaller located less than five feet above operating floor. Gas service valves shall be provided with worm gear actuators.
2. Size gear actuators for valves eight-inch diameter and smaller for 175 psig differential pressure.
3. Provide actuators capable of holding associated valves in any intermediate position without creeping or vibrating.
4. Provide valve position indicator on each actuator. Provide stop-limiting devices for open and closed position. For buried and submerged service actuators, provide position indicators in valve box.
5. Provide adjustable stop to adjust seating pressure.
6. Make packing accessible for adjustment without requiring removal of actuator from valve, except for valves in buried and submerged service.
7. Diameter ratio of handwheel or chainwheel and gear sector shall be less than two.
8. For buried and submerged valves, gear actuator shall be grease-packed and designed to withstand submersion, and shall be drip-tight in water 20 feet deep, with self-adjusting packing.
9. Provide each actuator with gearing totally enclosed.
10. Operator shaft and gear sector shall be supported on permanently lubricated bronze or stainless steel bearings.
11. Provide metal-encased spring loaded seals in top and bottom covers of gear housing, or O-ring seals.
12. Actuators shall be provided to produce indicated torque with maximum pull of 80 pounds on handwheel or chainwheel and maximum input of 150-foot pounds on operating nuts, for both seating and unseating heads equal to maximum differential pressure rating of valve.
13. Actuator components between input and stops shall be designed to withstand, without damage, a pull of 200 pounds for handwheel or chainwheel actuators and input torque of 300-foot pound for operating nuts when operating against stops.
14. Materials of Construction:
    a. Housing: Cast-iron, ASTM A126 Class B.
    b. Gear Sector: Cast-iron ASTM A126 Class B, or ductile iron ASTM A536.
    c. Worm Shaft: Steel, AISI 1144, hardened and tempered to an average Rc 40 and within range of Rc 35-45.
    d. Bearings: Bronze oil-impregnated, or stainless steel.
    e. Hardware, including bolts, nuts, washers, set screws, and pins, shall be Type 316 stainless steel.

2.6 ECCENTRIC PLUG VALVES (SMALLER THAN FOUR INCHES)

A. Manufacturers: Provide products of one of the following:
1. DeZurik.
2. Clow Valve Company (a division of McWane).
3. M&H Valve Company (a division of McWane).
4. Or equal.

B. General:
1. Provide eccentric-type plug valves each with rectangular ports.
2. Body shall be of one-piece construction.
3. Sizes: Smaller than Four-inch diameter.
4. Minimum Rated Working Pressure: 175 psig.
5. Maximum Fluid Temperature: 180 degrees F.

C. Materials of Construction:
   1. Body: Cast Iron ASTM A126 Class B, or Ductile-iron ASTM A536 Grade 65-45-12.
   2. Plug:
      a. Core: Cast Iron ASTM A126 Class B, or Ductile-iron, ASTM A536 Grade 65-45-12.
      b. Plug Facing: Neoprene.
   3. Stem: Type 304 Stainless Steel.
   4. Handle: Type 304 Stainless Steel.

2.7 STAINLESS STEEL BALL VALVES

A. Manufacturers: Provide products of one of the following:
   1. Victaulic Company.
   2. Milwauke Valve.
   3. Or equal.

B. General:
   1. Type: Quarter turn, full port ball valve.
   2. Sizes: Smaller than 4 Inches.
   3. Rating: 300 psig.
   4. End Connections: NPT Threaded.

C. Materials of Construction:
   1. Body: Type 316 Stainless Steel.
   2. Ball: Type 316 Stainless Steel.
   3. Seats: PTFE.
   4. Stem: Type 316 Stainless Steel.
   5. Handle, Bolts, Nuts, and Washers: Type 304 Stainless Steel.
   6. Handle cover: Plastic.

2.8 PVC BALL VALVES

A. Manufacturers: Provide products of one of the following:
   1. Nibco Incorporated.
   2. Hayward Flow Control Systems.
   3. ASAHI/America.
   4. Or equal.

B. General:
   1. Type: PVC shall be Type 4, Grade 1, in accordance with the requirements of ASTM D1784.
   2. Sizes: Smaller than Four Inches.
   3. Rating: 25 psig.
   4. End Connections: True union.

C. Materials of Construction:
   1. Body: Polyvinyl chloride (PVC).
   2. Gaskets and Seat: PTFE.

2.9 SWING CHECK VALVES

A. Manufacturers: Provide products of one of the following:
   1. APCO Willamette Valve & Primer Corp.
   2. Crispin Valve
   3. G.A. Industries.

4. Or equal.

B. General:
1. Provide valves conforming to AWWA C508 and as specified herein.
2. Sizes: Four-inch through 24-inch diameter.
3. Type: Resilient-seated.
4. Rated Working Pressure:
   a. Smaller than 12-inch Diameter: 175 psig.
   b. 12-inch Diameter and Larger: 150 psig.
5. Provide valves suitable for horizontal or vertical mounting.
6. Check valves shall have clear waterway with full-open area equal to nominal pipe size.
7. Provide check valves with outside adjustable weight and lever.
8. Provide valves larger than six-inch diameter with adjustable air cushion chambers.
9. Valve seats shall be mechanically attached and shall be field replaceable.

C. Materials of Construction: All materials of construction shall conform to AWWA C508 and shall be as follows:
1. Body, Disc, Cover and Gland: Cast-iron or ductile iron.
2. Disc Arm: Ductile iron.
3. Hinge Shaft: Type 316 stainless steel.
4. Hinge Shaft Bushings: Bronze, or Type 316 stainless steel for sewage service.
5. Shaft End Plate: Type 316 stainless steel.
6. Body Seat: Type 316 stainless steel.
7. Follower Ring for Rubber Seat on Disc: Type 316 stainless steel.
8. Disc Center Pin Assembly: Type 316 stainless steel.
9. Air Cushion Chamber:
   a. Chamber and Plunger: Bronze.
   b. Linkages and Pins: Type 316 stainless steel.
   c. Air Check Valve and Tubing: Brass or stainless steel.
10. Rubber Items:
   a. Applications Up to 180-degree F Fluid Temperature: Buna-N or other synthetic rubber suitable for the application.
   b. Applications 180-degrees F and Greater Fluid Temperature: Viton, or other synthetic rubber suitable for the application.
11. Internal and external bolting and other hardware; including pins, set screws, studs, bolts, nuts, and washers shall be Type 316 stainless steel.
12. Gland Packing: Graphite and Kevlar.

D. Interior Coating:
1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.

E. Testing:
1. Test each valve in manufacturer's shop in accordance with AWWA C508.
2. Allowable Leakage at Rated Pressures: Zero.

2.10 PRESSURE REDUCING VALVES

A. Manufacturers: Provide products of one of the following:
1. G.A. Industries, Inc.
2. CLA-VAL
3. Ross Valve
4. Or equal.

B. General:

1. Application: Reduce higher, fluctuating upstream pressure to a lower, steady, downstream pressure within specified range of flow variations.
2. Rated Working Pressure:
   a. Smaller than 12-inch Diameter: 250 psig.
3. Sizing Data:

Valve Size	6-inch	10-inch
Maximum Flow Rate	1800 gpm	3500 gpm
Maximum Upstream Pressure	150 psig	150 psig
Minimum Upstream Pressure	80 psig	80 psig
Setpoint Downstream Pressure	45 psig	45 psig

   a. Setpoint downstream pressure shall be field-adjustable over range of near-zero to 150 percent.
4. Valves shall not suffer cavitation damage within five-year period from date of Substantial Completion when exposed to specified operating conditions.

C. Valve Construction:
1. Type: Pilot-operated globe valves as shown.
2. Valves shall include one-piece piston and full-stroke length liner. Seating shall include replaceable resilient seat ring mounted on underside of piston and metal seat integral with liner or attached to valve body.
3. Provide V-ports for pressure control at low flows.
4. Flow area shall be equal to nominal pipe area when valve is fully open.
5. Valves shall provide drip-tight shut-off at rated pressure when closed.
6. Provide removable flanged cover to access valve's internals.
7. Provide indicator rod attached to piston for visual position indication of piston.
8. Pilot control piping shall include the following minimum items:
   a. Needle valve for field adjustment of closing speed.
   b. Pilot valve to adjust required setpoint downstream pressure.
   c. Wye strainer with valved blow-off connection.
   d. Isolation valves.

D. Materials of Construction:
1. Body: Cast-iron, ASTM A126 Class B, or ductile iron, ASTM A536.
2. Piston, Liner, Seat Crown, Indicator Rod and Hardware, Vent Tube and Glands: Bronze, ASTM B62.
3. Flexible Items: Nylon reinforced Buna-N, leather or other synthetic rubber suitable for the application.
4. Internal and external bolting and other hardware; including pins, set screws, studs, bolts, nuts, and washers: Type 316 stainless steel.
5. Packing: Teflon.
6. Control Piping Components (including piping, tubing, fittings, valves, and wye strainer): Brass or bronze with stainless steel wetted trim.

E. Interior Coating:
1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces shall be epoxy coated in accordance with AWWA C550.

F. Testing:
1. Test each assembled valve, except control piping, hydrostatically at 1.5 times rated working pressure of valve for minimum of five minutes per valve.
2. Test each valve for leakage at rated working pressure against closed valve. Test duration shall be minimum 15 minutes and allowable leakage shall be zero.

3. Perform functional test on each valve to verify proper operation at specified performance.

2.11 MUD VALVES

A. Manufacturers: Provide products of one of the following:
   1. Troy Valve.
   2. Trumbull.
   3. Or equal.

B. General:
   1. Sizes: 6-inch diameter.
   2. Mud valves shall be rising stem and flanged end type.
   3. Body ring shall be threaded and screwed into frame.
   4. Resilient seat mounted on plug shall provide positive sealing under both seating and unseating head conditions.
   5. Provide extension stem, stem guides, stem cover, and floorstand at elevation shown on the Contract Drawings. Valve appurtenances shall be as specified herein.
   6. Provide each valve with an electric motor actuator and integrated control station conforming to the requirements specified herein.
   7. Valves and controls shall be suitable for use in a Class I, Division 1 hazardous environment.

C. Materials of Construction:
   1. Body, Yoke, Stem, Plug, and Plates: Type 316 stainless steel, ASTM A193/A193M, Grade B.
   2. Plug Seat: Buna-N.
   3. Bolting hardware; including bolts, nuts, and washers shall be Type 316 stainless steel, ASTM A193/A193M Grade B.

2.12 SEWAGE AIR RELEASE VALVES

A. Manufacturers: Provide products of one of the following:
   1. G.A. Industries, Series 925.
   2. APCO.
   3. Vent-O-Mat.
   4. Val-Matic.
   5. Or equal.

B. General:
   1. All sewage air release and vacuum valves shall be specifically designed for operation on sewage and wastewater applications.
   2. Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice nozzle on a natural rubber seal affixed into the control float.
   3. Valves shall remain leak-tight in the absence of air.
   4. Pressure Rating: 150 pounds per square inch minimum, unless otherwise specified in the Valve Schedule.

C. Construction:
   1. The valve shall have an integral anti-surge orifice mechanism which shall operate automatically to limit surge pressures rise or shock induced by closure to less than two times the valve rated working pressure.
   2. Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice nozzle on a natural rubber seal affixed into the control float.
   3. Valves shall remain leak-tight in the absence of air.

D. Materials of Construction:
    a. Compact Tubular Single-Chamber Body and Cover: stainless steel.
    b. Hollow Direct Acting Float: stainless steel.
    c. Solid Cylindrical Large Orifice Control Float: stainless steel.
    d. Nozzle: stainless steel
    e. Woven Dirt-Inhibitor Screen: stainless steel.
    f. Seat: Buna-N.
    g. Seals: nitrile rubber.
    h. Lever Arms: Bronze or stainless steel.

2.13 SOLENOID VALVES

A. Manufacturers: Provide products of one of the following:
    1. Automatic Switch Company.
    2. Watts.
    3. Or equal.

B. General:
    1. Install a strainer upstream of each solenoid valve.
    2. Valves shall be energized to open (normally closed)
    3. Solenoid valves shall be suitable for operation on 120 volt, 60 Hz, single phase power.

C. Construction:
    1. Solenoid valves, where shown on the Drawings or required, shall be of packless construction with screwed ends and a threaded conduit connection.
    2. Parts in contact with the fluid being handled shall be of non-corrodible construction and suitable for the service indicated.
    3. Coils shall be rated for continuous duty, and shall be completely encapsulated in epoxy resin.

2.14 Balancing Valves:
A. Manufacturer: Provide product of one of the following:
    1. Bell & Gossett.
    2. Armstrong Limited.
    3. Or equal.

B. Units 2-inch and Smaller:
    1. Type: Globe style with venturi valve body for precise flow measurement, precise flow balancing, and positive drip-tight shutoff.
    2. Details of Construction:
        a. Body: Brass.
        b. Bonnet: Brass.
        c. Stem: Brass.
        d. Disk: Brass.
        e. O-Rings: EPDM.
        f. Handwheel: Reinforced nylon (ABS).
        g. Venturi shall have two brass metering ports with check valves and gasketted caps located on the inlet side of the valve.
    3. Valve shall have multi-turn, 360-degree adjustment with micrometer type indicator on handwheel. Minimum of five full 360-degree handwheel turns.
    4. Valve handle shall have hidden memory feature with tamper-proof balancing setting.
C. Units 2-1/2-inch and Larger:
    1. Type: Globe style valve body for precise flow measurement, precise flow balancing, and positive drip-tight shutoff.
    2. Details of Construction:

a. Body: Cast iron.
b. Disc: Bronze.
c. Seat: EPDM.
d. Stem: Brass.
e. Trim: Brass.
f. O-Rings: Buna and EPDM.
g. Handwheel: Reinforced nylon (ABS).
h. Two brass metering ports with check valves and gasketted caps.

3. Valve shall have multi-turn, 360-degree adjustment with micrometer type indicator on handwheel. Minimum of five full 360-degree handwheel turns.
4. Valve handle shall have hidden memory feature with tamper-proof balancing setting.

2.15 FIRE HYDRANTS

A. Products and Manufacturers: Provide one of the following:
1. Mueller, Centurian No. A-423 "Super Centurian 250";
2. Kennedy K-81-A, D "Guardian";
3. American Darling Valve B-62-B;
4. Or equal.

B. General:
1. Provide dry-barrel fire hydrants conforming to AWWA C502, Underwriters Laboratories-listed and Factory Mutual approved, and as specified herein.
2. Rated Working Pressure: 175 psig, minimum.
3. Rated Hydrostatic Test Pressure: 400 psig, minimum.
4. Length of Bury: as shown.
5. Each hydrant shall be able to deliver 1500 gallons minimum through its two 2.5-in hose nozzles when opened together with a loss of not more than 2 psi in the hydrant.

C. Construction:
1. Type: Three-way fire hydrants with two hose nozzles and one pumper nozzle.
2. Nozzles:
a. Provide one 4.5-inch diameter pumper nozzle and two 2.5-inch diameter hose nozzles with NFPA threads.
b. Nozzles shall be O-ring sealed, threaded, and retained with stainless steel locks. Nozzles shall be field replaceable.
3. Main Valve and Drainage Assembly:
a. Opening: 5.25-inch diameter, obstructed only by the valve rod..
b. Main valve shall be compression type provided with upper and lower metal plates and lower valve plate nut.
c. Barrel drainage shall be through dual drain valves. Opening and closing of main valve shall cause force-flush of dual drain ports.
d. Main valve seat ring shall be easily replaceable from above-ground.
e. Operating nut shall be AWWA Standard pentagonal type, measuring 1.5-in. point to flat.
f. Hydrants shall be designed such that the hydrant valve closes with line pressure preventing loss of water and consequent flooding in the event of traffic damage.
4. Provide an oil filled reservoir for lubrication of stem threads and bearing surfaces. Oil shall be U.S. Food and Drug Administration approved and ANSI/NSF 61-listed, and shall flow freely in temperature range of -60 to 158 degrees F.
5. Provide traffic flange in barrel and safety coupling in stem.
6. Inlet Connection: Six-inch diameter mechanical joint, restrained.
7. Hydrants shall be so arranged that the direction of outlets may be turned 90 degrees without interference with the drip mechanism or obstructing the discharge from any outlet.

8. Hydrants shall open by turning operating nut to the right (clockwise) and shall be marked with a raised arrow and the word "open" to indicate the direction to turn stem to open hydrant.

D. Materials of Construction: Materials of construction shall conform to the requirements of AWWA C502 and shall be as follows:
   1. Upper and Lower Barrels, Shoe, and Bonnet: Cast-iron.
   2. Stem and Accessories:
      a. Upper and Lower Stems: Steel.
      b. Operating Nut: Bronze.
      c. Safety Coupling: Stainless steel.
   3. Nozzles:
      a. Pumper and Hose Nozzles: Bronze.
      b. Nozzle Caps: Cast-iron.
      c. Nozzle Cap Washer: Buna-N rubber.
      c. Cap Chains: Galvanized steel.
      d. Chain Holder: Galvanized steel.
   4. Main Valve Assembly:
      a. Main Valve: Rubber.
      b. Upper Valve Plate: Bronze.
      c. Lower Valve Plate and Nut: Cast-iron.
   5. Drain Valves:
      a. Drain Ring Housing: Cast-iron.
      b. Drain Ring: Bronze.
   6. O-ring Gaskets: Rubber.
   7. External Assembly Bolts: Steel.
   8. Internal Pins and Other Hardware: Stainless steel, ASTM A276.

E. Testing:
   1. Test each fire hydrant in manufacturer's shop in conformance with AWWA C502.

F. Interior Coating:
   1. Hydrants shall be coated on the interior. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.

G. Exterior Painting:
   1. Below- and above-ground painting shall be as specified under Article 2.22 and Article 2.23 of this Section, respectively.

2.16 QUICK DISCONNECT COUPLINGS

A. 6-inch Quick Disconnect Couplings:
   1. Manufacturers: Provide products of one of the following:
      a. Dixon Valve and Coupling Company,
      b. United Pacific Distributors Supply, Inc.,
      c. Or equal.

   2. General:
      a. Coupling shall be of the twin cam type manufactured to the dimensional specifications of MIL-C-27487. The coupler shall be of the female type to receive a male hose coupler from a septage hauler truck. The coupler shall be of stainless steel construction, with Buna-N gaskets.
      b. Provide a separate adapter to permit connection to the female coupler by a septage hauler with a female hose coupler.

A. Quick Disconnect Couplings (smaller than 6-inch):
   1. Stainless Steel Construction – General Requirements:
      a. All coupling assemblies shall have a minimum pressure and temperature rating of 300 pounds per square inch and 225 degrees F.
      b. Provide finger rings for all sizes 1-1/2 inch and above.
      c. Size and Location: As shown on the Drawings and as specified.
      d. Provide increaser or reducer fittings when connection is required for dissimilar size.
   2. Adapter with Male NPT:
      a. Construction: Stainless steel.
      b. Manufacturer and Model No.:
         1) Dover Corp. OPW Division, 633-F,
         2) Dixon Valve and Coupling Company, Global F-SS,
         3) Or equal.
   3. Adapter with Female NPT:
      a. Construction: Stainless steel.
      b. Manufacturer and Model No.:
         1) Dover Corp. OPW Division, 633-A,
         2) Dixon Valve and Coupling Company, Global A-SS,
         3) Or equal.
   4. Adapter with Hose Shank:
      a. Construction: Stainless steel.
      b. Manufacturer and Model No.:
         1) Dover Corp. OPW Division, 633-E,
         2) Dixon Valve and Coupling Company, Global E-SS,
         3) Or equal.
   5. Coupler with Male NPT:
      a. Construction: Stainless steel.
      b. Gasket: Buna-N or other material as required to be compatible with fluid being handled..
      c. Manufacturer and Model No.:
         1) Dover Corp. OPW Division, 633-B,
         2) Dixon Valve and Coupling Company, Global B-SS,
         3) Or equal.
   6. Coupler with Hose Shank:
      a. Construction: Stainless steel.
      b. Gasket: Buna-N or other material as required to be compatible with fluid being handled.
      c. Manufacturer and Model No.:
         1) Dover Corp. OPW Division, 633-C,
         2) Dixon Valve and Coupling Company, Global C-SS,
         3) Or equal.
   7. Coupler with Female NPT:
      a. Construction: Stainless steel.
      b. Gasket: Buna-N or other material as required to be compatible with fluid being handled..
      c. Manufacturer and Model No.:
         1) Dover Corp. OPW Division, 633-D,
         2) Dixon Valve and Coupling Company, Global D-SS,
         3) Or equal.
   8. Coupler Plug:
      a. Construction: Stainless steel.
      b. Manufacturer and Model:
         1) Dover Corp. OPW Division, 634-A,
         2) Dixon Valve and Coupling Company, Global A-SS,
         3) Or equal.

9. Adapter Cap:
    a. Construction: Stainless steel.
    b. Manufacturer and Model:
        1) Dover Corp. OPW Division, 634-B,
        2) Dixon Valve and Coupling Company, Global B-SS,
        3) Or equal.

2.17 SANITARY TANK HATCH

A. Manufacturers: Provide products of one of the following:
    1. OPW Fueling Containment Systems, Part Number 269-0085.
    2. Trumbull Recreation Supply, Product Code DSVGT2.
    3. Or equal.

B. General:
    1. Hatch shall be foot-operated and quick-opening/closing for clean emptying of sanitary waste from RVs, campers and travel trailers.
    2. Body: Coated Ductile Iron or Cast Iron.
    3. Cap: Cast Zinc or Bronze.

2.18 ELECTRIC ACTUATORS (OPEN/CLOSE)

A. Manufacturers: Provide products of one of the following:
    1. Rotork.
    2. No substitutions allowed.

B. Application Criteria:
    1. Ambient Temperature Rating: -20 to +158 degrees F.
    2. Ambient Humidity: 100 percent.
    3. Application: Refer to Schedule of Valves at the end of this Section.
    4. Power Supply: 480-volt, three-phase, 60 Hertz.
    5. Control Voltage: 120 VAC, single phase, 60 Hertz.
    6. Torques: As determined by valve manufacturer/gate manufacturer.
    7. Duty Cycle: Sixty starts per hour, minimum.
    8. Sluice gate actuators shall be designed to move the gate approximately 12-inches per minute under full load.

C. General:
    1. Conform to AWWA C540 and this Section.
    2. Provide actuator operable with handwheel or chainwheel, even after disengaging and removing electric motor.
    3. Provide valves with electric actuators that are located more than five feet above operating floor with separate control panels installed so that panel controls and indicators are approximately five feet above operating floor, at location approved by Engineer. Modify electrical wiring as required for remote location of control panels.
    4. Coordinate sizing of each electric actuator with valve manufacturer, who shall furnish valve and associated electric actuator and appurtenances as a unit.
    5. Electric actuators shall be suitable for valve orientation as shown.

D. Electric Motor:
    1. General:
        a. Provide motors suitable for “open/close” service, with high torque characteristics and minimum 70 degree C temperature rating.
    2. Motor Construction:
        a. Enclosure: NEMA 4X, unless NEMA 7 is required for duty in the actuator location.

b. Insulation: Class F.
c. Service Factor: 1.5 times valve torque requirement.
d. Provide winding thermostats for overcurrent protection.
e. Bearings: Anti-friction with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.

E. Actuator Gearing:
1. Housing: Die-cast aluminum or cast-iron.
2. Close-coupled to electric motor.
3. Input Shaft Gearing: Spur or bevel gear assembly.
4. Output Shaft Gearing: Self-locking worm gears with minimum gear backlash to prevent valve disc chatter or vibration.
5. Gearing shall be of hardened alloy steel or combination of hardened alloy steel and alloy bronze, accurately cut by hobbing machine.
6. Lubrication: Oil bath.
7. Bearings: Ball or roller with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.
8. Input Shaft: Hardened alloy steel.
9. Provide mechanical stops adjustable to plus-or-minus five degrees at each end of travel.

F. Limit Switches:
1. Provide each actuator with “end of travel” limit switches to allow control of desired end position for each direction of travel.
2. Provide open and close limit switches geared to drive mechanism and in step at all times, whether unit is operated electrically or manually, and whether or not actuator is powered by electric power supply. Friction devices or set-screw arrangements shall not be used to maintain the setting.
3. Limit switch gearing shall be appropriately lubricated.
4. Provide driven mechanism totally enclosed to prevent entrance of foreign matter and loss of lubricant.

G. Torque Switches:
1. Provide adjustable torque switches with each valve actuator. Torque switches shall operate during complete valve cycle without using auxiliary relays, linkages, latches, or other devices.
2. Wire torque switches to de-energize valve actuator motor when excessive torque is developed during each direction of travel.
3. It shall be possible to select the torque switches to control open and close limit positions in each direction of valve travel.

H. Handwheel and Chainwheel Operation:
1. Provide actuator with handwheel (or chainwheel as required) for manual operation, so connected that operation by motor will not cause handwheel or chainwheel to rotate.
2. Should electric power be returned to motor while handwheel or chainwheel is in use, unit shall prevent transmission of motor torque to handwheel or chainwheel.
3. Handwheel or chainwheel shall require no more than 80-pound effort on rim for seating or unseating load, and no more than 60 pounds on running load.
4. Handwheel or chainwheel shall have an arrow and the word “OPEN” or “CLOSE” indicating required rotation. Handwheel or chainwheel shall operate in clockwise direction to close.
5. Chain Operators:
a. Valves more than five feet above operating floor level shall be equipped with chain operators.
6. Handwheels and chain operators shall be as specified in Article 2.18 of this Section.
7. Provide stem covers for rising stem gate valves as specified in Article 2.18 of this Section.

I. Controls:
   1. Provide the following controls in separate compartment integral with actuator.
   2. Enclosure: NEMA 4X, unless NEMA 7 is required for duty in the actuator location.
   3. Starter: Actuator shall include reversing motor controls. Supply a fused disconnect switch in a separate enclosure that is rated for the same area of classification. For nonhazardous areas, supply NEMA 4X, 316 SS enclosure. For Hazardous areas, supply Class 1 Div 2 cast aluminum housing.
   4. Control Power Transformer: Provide transformer to transform rated three-phase, 60 Hertz power to 120 volts, single-phase. Transformer shall be complete with grounded and fused secondary and dual primary fuses.
   5. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close" control from remote source shall be enabled.
   6. Provide "OPEN/CLOSE" pushbuttons with hold-to-run or momentary contact selection.
   7. Provide "OPEN/CLOSE" indicating lights and zero-to-100 percent position indication in liquid crystal display window.
   8. Provide thermal overload and single-phasing protection of motor.
   9. Actuator circuit boards shall be rated for high temperature service, minimum 55 degrees C.
   10. Provide electrical interlocks as shown.

J. Remote-mounted Actuator Control Stations:
   1. Where required by valve location or as indicated, provide remote control panels.
   2. Enclosure: NEMA 4X, unless NEMA 7 is required for duty in the actuator location.
   3. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close" control from remote source shall be enabled Provide contact when switch is in "REMOTE" position for remote indication.
   4. Provide "OPEN/CLOSE" pushbuttons with hold-to-run or momentary contact selection.
   5. Provide "OPEN/CLOSE" indicating lights and zero-to-100 percent position indication with liquid crystal display.

K. Testing:
   1. Test each actuator in manufacturer's shop in conformance with AWWA C540.

2.19 ELECTRIC ACTUATORS (OPEN/CLOSE, Devicenet)

A. Manufacturers: Provide products of one of the following:
   1. Rotork.
   2. No substitutions allowed.

B. Application Criteria:
   1. Ambient Temperature Rating: -20 to +158 degrees F.
   2. Ambient Humidity: 100 percent.
   3. Application: Refer to Schedule of Valves at the end of this Section.
   4. Power Supply: 480-volt, three-phase, 60 Hertz.
   5. Control Voltage: 120 VAC, single phase, 60 Hertz.
   6. Torques: As determined by valve manufacturer/gate manufacturer.
   7. Duty Cycle: Sixty starts per hour, minimum.
   8. Sluice gate actuators shall be designed to move the gate approximately 12-inches per minute under full load.

C. General:

1. Conform to AWWA C540 and this Section.
2. Provide actuator operable with handwheel or chainwheel, even after disengaging and removing electric motor.
3. Provide valves with electric actuators that are located more than five feet above operating floor with separate control panels installed so that panel controls and indicators are approximately five feet above operating floor, at location approved by Engineer. Modify electrical wiring as required for remote location of control panels.
4. Coordinate sizing of each electric actuator with valve manufacturer, who shall furnish valve and associated electric actuator and appurtenances as a unit.
5. Electric actuators shall be suitable for valve orientation as shown.

D. Electric Motor:
   1. General:
      a. Provide motors suitable for "open/close" service, with high torque characteristics and minimum 70 degree C temperature rating.
   2. Motor Construction:
      a. Enclosure: NEMA 4X, unless NEMA 7 is required for duty in the actuator location.
      b. Insulation: Class F.
      c. Service Factor: 1.5 times valve torque requirement.
      d. Provide winding thermostats for overcurrent protection.
      e. Bearings: Anti-friction with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.

E. Actuator Gearing:
   1. Housing: Die-cast aluminum or cast-iron.
   2. Close-coupled to electric motor.
   3. Input Shaft Gearing: Spur or bevel gear assembly.
   4. Output Shaft Gearing: Self-locking worm gears with minimum gear backlash to prevent valve disc chatter or vibration.
   5. Gearing shall be of hardened alloy steel or combination of hardened alloy steel and alloy bronze, accurately cut by hobbing machine.
   6. Lubrication: Oil bath.
   7. Bearings: Ball or roller with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.
   8. Input Shaft: Hardened alloy steel.
   9. Provide mechanical stops adjustable to plus-or-minus five degrees at each end of travel.

F. Limit Switches:
   1. Provide each actuator with "end of travel" limit switches to allow control of desired end position for each direction of travel.
   2. Provide open and close limit switches geared to drive mechanism and in step at all times, whether unit is operated electrically or manually, and whether or not actuator is powered by electric power supply. Friction devices or set-screw arrangements shall not be used to maintain the setting.
   3. Limit switch gearing shall be appropriately lubricated.
   4. Provide driven mechanism totally enclosed to prevent entrance of foreign matter and loss of lubricant.

G. Torque Switches:
   1. Provide adjustable torque switches with each valve actuator. Torque switches shall operate during complete valve cycle without using auxiliary relays, linkages, latches, or other devices.
   2. Wire torque switches to de-energize valve actuator motor when excessive torque is developed during each direction of travel.

3. It shall be possible to select the torque switches to control open and close limit positions in each direction of valve travel.

H. Handwheel and Chainwheel Operation:
1. Provide actuator with handwheel (or chainwheel as required) for manual operation, so connected that operation by motor will not cause handwheel or chainwheel to rotate.
2. Should electric power be returned to motor while handwheel or chainwheel is in use, unit shall prevent transmission of motor torque to handwheel or chainwheel.
3. Handwheel or chainwheel shall require no more than 80-pound effort on rim for seating or unseating load, and no more than 60 pounds on running load.
4. Handwheel or chainwheel shall have an arrow and the word "OPEN" or "CLOSE" indicating required rotation. Handwheel or chainwheel shall operate in clockwise direction to close.
5. Chain Operators:
   a. Valves more than five feet above operating floor level shall be equipped with chain operators.
6. Handwheels and chain operators shall be as specified in Article 2.18 of this Section.
7. Provide stem covers for rising stem gate valves as specified in Article 2.18 of this Section.

I. Controls:
1. Provide the following controls in separate compartment integral with actuator.
2. Enclosure: NEMA 4X, unless NEMA 7 is required for duty in the actuator location.
3. Starter: Actuator shall include reversing motor controls. Supply a fused disconnect switch in a separate enclosure that is rated for the same area of classification. For nonhazardous areas, supply NEMA 4X, 316 SS enclosure. For Hazardous areas, supply Class 1 Div 2 cast aluminum housing.
4. Control Power Transformer: Provide transformer to transform rated three-phase, 60 Hertz power to 120 volts, single-phase. Transformer shall be complete with grounded and fused secondary and dual primary fuses.
5. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close" control from remote source shall be enabled.
6. Provide "OPEN/CLOSE" pushbuttons with hold-to-run or momentary contact selection.
7. Provide "OPEN/CLOSE" indicating lights and zero-to-100 percent position indication in liquid crystal display window.
8. Provide thermal overload and single-phasing protection of motor.
9. Actuator circuit boards shall be rated for high temperature service, minimum 55 degrees C.
10. Provide electrical interlocks as shown.
11. Provide DeviceNet network communication as indicated in Article J below.

J. DeviceNet Communication:
1. Remote control for the valve/gate actuators shall be via a digital control and feedback highway. Network communications shall be via DeviceNet bus protocol. Actuators shall be compatible with the international standard published by the ODVA Open DeviceNet Vendors Association. In addition, the communications module fitted in the valve/gate actuator shall be independently tested and certified by the ODVA as conforming to the DeviceNet standard.
2. Optical isolation between the communications driver circuits and the internal actuator processors shall be provided to prevent unwanted communications errors due to poor system integration or ground loop currents.
3. The following discrete signals shall be made available from the valve/gate actuator over the network:
   a. Actuator travel.
   b. Actuator travel direction.

c. Closed.
d. Opened.
e. Thermal trip.
f. Actuator Not In remote.
g. Valve/Gate malfunction.

4. The following discrete signals shall be made available to the valve/gate actuator over the network:
   a. Open.
   b. Close.
5. The following analog signals shall be made available to the valve/gate actuator over the network:
   a. Position %.
6. Parameters that can be set over the network, for fine tuning of the control, are to included but not limited to the following:
   a. Action on loss of communications.
   b. Manual movement detection.
   c. DeviceNet address (MAC ID).
   d. Network baud rate.

K. Remote-mounted Actuator Control Stations:
1. Where required by valve location or as indicated, provide remote control panels.
2. Enclosure: NEMA 4X, unless NEMA 7 is required for duty in the actuator location.
3. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close" control from remote source shall be enabled Provide contact when switch is in "REMOTE" position for remote indication.
4. Provide "OPEN/CLOSE" pushbuttons with hold-to-run or momentary contact selection.
5. Provide "OPEN/CLOSE" indicating lights and zero-to-100 percent position indication with liquid crystal display.

L. Testing:
1. Test each actuator in manufacturer's shop in conformance with AWWA C540.

2.20 ELECTRIC ACTUATORS (MODULATING)

A. Manufacturers: Provide products of one of the following:
1. Rotork.
2. No substitutions allowed.

B. Application Criteria:
1. Ambient Temperature Rating: -20 to +158 degrees F.
2. Ambient Humidity: 100 percent.
3. Application: Refer to Schedule of Valves at the end of this Section.
4. Duty Cycle: Continuous (minimum 1,200 starts/stops per hour), unless otherwise specified.
5. Power Supply: 480 VAC, three-phase, 60 Hertz.
6. Control Voltage: 120 VAC, single-phase, 60 Hertz.
7. Torque: As recommended by valve manufacturer/gate manufacturer.
8. Accepts 4 to 20 mADC input to positioner.
9. Sluice gate actuators shall be designed to move the gate approximately 12-inches per minute under full load.

C. General:
1. Conform to AWWA C540 and this Section.

2. Provide actuator operable with handwheel even after electric motor has been disengaged and removed.
3. Provide each valve with electric actuators located more than five feet above operating floor with separate control panel installed with controls and indicators approximately five feet above operating floor at location approved by Engineer. Modify electrical wiring as required for remote location of control panels.
4. Coordinate sizing of each electric actuator with valve manufacturer who shall furnish valve and electric actuator as a unit.
5. Electric actuators shall be suitable for valve orientation shown.

D. Electric Motor:
1. General:
   a. Provide motors suitable for modulating service, of high torque characteristics and minimum 70 degrees C temperature rating.
2. Motor Construction:
   a. Enclosure: NEMA 4X, unless NEMA 7 is required for duty in the actuator location.
   b. Insulation: Class H for three-phase AC motors, Class F for DC motors.
   c. Service Factor: 1.5 times valve torque requirement.
   d. Provide winding thermostats for overcurrent protection.
   e. Bearings: Anti-friction, B-10 life of 100,000 hours, lifetime pre-lubri-cated and sealed.

E. Actuator Gearing:
1. Housing: Die-cast aluminum.
2. Close-coupled to electric motor.
3. Input Shaft Gearing: Spur or bevel gear assembly.
4. Output Shaft Gearing: Self-locking worm gears with minimum gear backlash to prevent valve disc chatter or vibration.
5. Gearing shall be of hardened alloy steel or combination of hardened alloy steel and alloy bronze, accurately cut by hobbing machine.
6. Lubrication: Grease or oil bath.
7. Bearings: Ball or roller with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.
8. Input Shaft: Hardened alloy steel.
9. Provide mechanical stops adjustable to plus-or-minus five degrees at each end of travel.
10. Provide mechanical position indication.

F. Limit Switches:
1. Provide each actuator with “END OF TRAVEL” limit switches to allow control of desired end position for each direction of travel.
2. Provide “OPEN” and “CLOSE” limit switches geared to drive mechanism and in step at all times, whether unit is operated electrically or manually and whether or not actuator is electrically powered. Friction devices or set-screw arrangements shall not be used to maintain setting.
3. Limit switch gearing shall be appropriately lubricated.
4. Provide drive mechanism totally enclosed to prevent entrance of foreign matter or loss of lubricant.

G. Torque Switches:
1. Provide adjustable double-torque switches with valve actuator.
2. Torque switches shall operate during complete valve cycle without using auxiliary relays, linkages, latches, or other devices.
3. Wire torque switches to de-energize valve actuator motor when excessive torque is developed during each direction of travel.

4. It shall be possible to select torque switches to control open and close limit positions in each direction of valve travel.

H. Handwheel and Chainwheel Operation:
1. Equip actuator with handwheel or chainwheel for manual operation, so connected that operation by motor will not cause handwheel or chainwheel to rotate.
2. Should power be returned to motor while handwheel or chainwheel is in use, unit shall prevent transmission of motor torque to handwheel or chainwheel.
3. Handwheel or chainwheel shall require no more than 80-pound effort on rim for seating or unseating load, and no more than 60-pound effort on running load.
4. Handwheel or chainwheel shall have an arrow and word "OPEN" or "CLOSE" indicating required rotation. Handwheel or chainwheel shall operate in clockwise direction to close.
5. Chain Operators:
a. Provide valves located more than five feet above operating floor with chain operators.
6. Handwheels and chain operators shall be as specified in Article 2.18 of this Section.

I. Controls:
1. Provide following controls in a separate compartment integral with the actuator.
2. Enclosure: NEMA 4X, unless NEMA 7 is required for duty in the actuator location.
3. Starter: Actuator shall include reversing motor controls. Supply a fused disconnect switch in a separate enclosure that is rated for the same area of classification. For nonhazardous areas, supply NEMA 4X, 316 SS enclosure. For Hazardous areas, supply Class 1 Div 2 cast aluminum housing.
4. Control Power Transformer: Provide transformer to transform rated three-phase, 60 Hertz power to 120 volts, single-phase. Transformer shall be complete with grounded and fused secondary and dual primary fuses.
5. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close" control from remote source shall be enabled.
6. Provide "OPEN/CLOSE" pushbuttons with hold-to-run or momentary contact selection.
7. Provide "OPEN/CLOSE" indicating lights and zero-to-100 percent position indication in liquid crystal display window.
8. Motor shall be de-energized when valve is jammed.
9. Provide thermal overload and single phasing protection of motor.
10. For monitoring of actuator, provide set of single-pole/double-throw (SPDT) dry contacts. Monitor relay shall indicate that actuator is available for remote operation.
11. Provide each actuator with position controller. Controller shall have the following features:
    a. Adjustments for duty cycle, band width, span, and zero.
    b. On loss of control signal valve shall stay in its last position.
    c. Provision for adequate cooling of actuator.
12. Provide actuator with position transmitter. Transmitter shall be standard slidewire (potentiometer) position transducer providing an output corresponding to zero-to-100 percent of travel. Accuracy shall be plus-or-minus one percent of scale. Transmitter shall include integral temperature-compensated, constant-voltage source for slidewire excitation. Transmitter shall be integral to actuator.
13. Supply actuator with circuit boards for high temperature service, minimum 55 degrees C.
14. Provide 120 VAC space heaters to maintain internal housing temperature at 20 degrees C.
15. Provide DeviceNet network communication as indicated in Article J below.

J. DeviceNet Communication:
1. Remote control for the valve actuators shall be via a digital control and feedback highway. Network communications shall be via DeviceNet bus protocol. Actuators shall be compatible with the international standard published by the ODVA Open DeviceNet Vendors Association. In addition, the communications module fitted in the valve actuator

shall be independently tested and certified by the ODVA as conforming to the DeviceNet standard.

2. Optical isolation between the communications driver circuits and the internal actuator processors shall be provided to prevent unwanted communications errors due to poor system integration or ground loop currents.
3. The following discrete signals shall be made available from the valve actuator over the network:
    a. Actuator travel.
    b. Actuator travel direction.
    c. Closed.
    d. Opened.
    e. Thermal trip.
    f. Actuator in remote.
    g. Valve malfunction.
4. The following analog signals shall be made available from the valve actuator over the network:
    a. Valve position.
5. The following discrete signals shall be made available to the valve actuator over the network:
    a. Open.
    b. Close.
6. The following analog signals shall be made available to the valve actuator over the network:
    a. Desired valve position.
7. Parameters that can be set over the network, for fine tuning of the control, are to included but not limited to the following:
    a. Action on loss of communications.
    b. Positioner deadband.
    c. Positioner hysteresis.
    d. Manual movement detection.
    e. Analogue input value scaling.
    f. DeviceNet address (MAC ID).
    g. Network baud rate.

K. Remote-mounted Control Stations:
1. Where required by valve location or as indicated, provide remote control panels.
2. Enclosure: NEMA 4X, unless NEMA 7 is required for duty in the actuator location.
3. Provide “LOCAL/OFF/REMOTE” selector switch. In “LOCAL” position actuator shall be operated by “OPEN/CLOSE” pushbuttons. In “OFF” position, actuator shall be disabled from local and remote operation. In “REMOTE” position, “open/close” control from remote source shall be enabled Provide contact when switch is in “REMOTE” position for remote indication.
4. Provide “OPEN/CLOSE” pushbuttons with hold-to-run or momentary contact selection.
5. Provide “OPEN/CLOSE” indicating lights and zero-to-100 percent position indication with liquid crystal display.

L. Testing:
1. Test each actuator in manufacturer’s shop in conformance with AWWA C540.

2.21 APPURTENANCES FOR METALLIC VALVES

A. General:
1. For valves located less than five feet above operating floor, provide levers on four-inch diameter quarter-turn valves, and provide handwheels on all other valves, unless otherwise shown or specified.

2. For valves located five feet or more above operating floor, provide chain operators.
3. Where indicated, provide extension stems and floorstands.

B. Handwheels:
1. Conform to applicable AWWA standards.
2. Material of Construction: Ductile iron, or cast aluminum.
3. Arrow indicating direction of opening and word "OPEN" shall be cast on trim of handwheel.
4. Maximum Handwheel Diameter: 2.5 feet.

C. Chain Operators:
1. Chains shall extend to three feet above operating floor.
2. Provide 1/2-inch stainless steel hook bolt to keep chain out of walking area.
3. Materials of Construction:
   a. Chain: Type 316L stainless steel.
   b. Chainwheel: Recessed groove type made out of Type 316 stainless steel.
   c. Guards and Guides: Type 316L stainless steel.
4. Chain Construction:
   a. Chain shall be of welded link type with smooth finish. Chain that is crimped or has links with exposed ends is unacceptable.
5. Provide geared operators where required to position chainwheels in vertical position.

D. Crank Operator:
1. Crank operator shall be removable and fitted with rotating handle.
2. Maximum Radius of Crank: 15 inches.
3. Materials:
   a. Crank: Cast-iron or ductile iron.
   b. Handle: Type 304 stainless steel.
   c. Hardware: Type 304 stainless steel.

E. Extension Stems and Floor Stands:
1. Conform to the applicable requirements of AWWA C501 for sizing of complete lifting mechanism.
2. Bench and Pedestal Floor Stands:
   a. For valves requiring extension stems, provide bench or pedestal floor stands with handwheel or crank as indicated. Provide provisions for using portable electric actuator for opening and closing of valves.
   b. Type: Heavy-duty with tapered roller bearings enclosed in a weatherproof housing, provided with positive mechanical seals around lift nut and pinion shaft to prevent loss of lubrication and to prevent moisture from entering housing. Provide lubrication fitting for grease. For valves conveying water that is potable or that will be treated to become potable, grease shall be food-grade and ANSI/NSF 61-listed. Base shall be machined.
   c. Materials of Construction:
      1) Housing: Cast-iron, ASTM A126, Class B.
      2) Lift Nut: Cast bronze, ASTM B98/B98M.
      3) Grease Fitting: Stainless steel.
      4) Bolting: Type 316 stainless steel.
3. Wall brackets for floor stands shall be Type 316L stainless steel construction.
4. Extension Stems:
   a. Materials of Stems and Stem Couplings: Type 316 stainless steel.
   b. Maximum Slenderness Ratio (L/R): 100.
   c. Minimum Diameter: 1.5-inch.
   d. Threads: Acme.

e. Provide stem couplings where stems are furnished in more than one piece. Couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.
f. Weld to bottom of extension stem a Type 316 stainless steel cap suitable for square end of valve stem.

5. Bottom Couplings: Ductile iron with Type 316 stainless steel pin and set screw.
6. Stem Guides:
   a. Material: Type 316 cast stainless steel with bronze bushing for stem. For submerged service, Type 316 cast stainless steel with stainless steel bushing for stem.
   b. Maximum Stem Length Between Guides: Seven feet.
   c. Stem guides shall be adjustable in two directions.
7. Furnish stem cover of clear butyrate plastic or Grade 153 Lexan with cast adapter for mounting cover to bench and floor stands. Provide stem cover with gasketing and breathers to eliminate water intrusion into operator and condensation within cover. Provide stem cover with mylar tape with legible markings showing valve position at one-inch intervals and open and close limits of valve.

F. Floor Boxes: Provide cast-iron floor boxes for valves that are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast-iron covers and be fitted with bronze bushing.

2.22 ANCHORAGES AND MOUNTING HARDWARE

A. General:
1. Comply with Section 05051, Anchor Systems, except as modified in this Section.
2. Obtain bolts, nuts, and washers for connection of valve and appurtenances to concrete structure or other structural members from valve Supplier.
3. Bolts, nuts, and washers shall be of ample size and strength for purpose intended. Anchorages in concrete shall be at least 5/8-inch diameter.
4. Provide stem guide anchorages of required strength to prevent twisting and sagging of guides under load.
5. Materials: Provide bolts and washers of Type 316 stainless steel and nitrided nuts. Bolts shall have rolled threads. Bolts and nuts shall be electropolished to remove burrs.

2.23 TOOLS, LUBRICANTS AND SPARE PARTS

A. Provide T-handle operating wrenches, minimum 12-inch length, for buried valves.

B. Lubricants: For valves, actuators, and appurtenances requiring lubricants, provide suitable lubricants for initial operation and for first year of use following Substantial Completion. Lubricants for equipment associated with conveying potable water or water that will be treated to become potable shall be food-grade and ANSI/NSF 61-listed.

C. List of spare parts recommended by the manufacturer. The list shall describe each part, the quantity recommended, and the unit price of each part.

2.24 PAINTING OF EXPOSED VALVES, HYDRANTS AND APPURTENANCES

A. Exterior steel, cast-iron, and ductile iron surfaces, except machined surfaces of exposed valves and appurtenances, shall be finish painted in manufacturer's shop. Surface preparation, priming, finish painting, and field touch-up painting shall conform to Section 09900, Painting, unless otherwise specified.

2.25 PAINTING OF BURIED VALVES AND HYDRANTS

A. The interior ferrous metal surfaces, except finished or bearing surfaces, shall be blast cleaned in accordance with SSPC SP-10 and painted with two coats of an approved two-component epoxy coating specifically formulated for potable water use. The coating shall be NSF certified to Standard 61.

B. Exterior ferrous metal surfaces of all buried valves and hydrants shall be blast cleaned in accordance with SSPC SP-6 and given two shop coats of an approved two-component coal tar epoxy paint.

2.26 INSPECTION AND WITNESS SHOP TESTS

A. Allow for Engineer and Owner to inspect and witness valve tests at valve manufacturer's facility.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment are to be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

B. During installation of all valves and appurtenances, verify that all items are clean, free of defects in material and workmanship and function properly.

C. All valves shall be closed and kept closed until otherwise directed by the Construction Manager.

3.2 INSTALLATION

A. General:
   1. Install valves and appurtenances in accordance with:
      a. Supplier's instructions and the Contract Documents.
      b. Requirements of applicable AWWA standards.
      c. Applicable requirements of Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
   2. Install valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment, and other causes.
   3. Position swing check valves so that, when valve is fully open, valve disc does not conflict with piping system elements upstream and downstream of valve.

B. Exposed Valves:
   1. Provide supports for large or heavy valves and appurtenances as shown or required to prevent strain on adjoining piping.
   2. Operators:
      a. Install valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves, piping, structure, and equipment, and as approved by Engineer.
      b. Avoid placing operators at angles to floors or walls.
      c. Orient chain operators out of way of walking areas.
      d. Install valves so that indicator arrows are visible from floor level.
      e. For motor-operated valves located lower than five feet above operating floor, orient motor actuator to allow convenient access to pushbuttons and handwheel.
   3. Floor Stands and Stems:
      a. Install floor stands as shown and as recommended by manufacturer.
      b. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by manufacturer.

c. Provide sleeves where operating stems pass through floor. Extend sleeves two inches above floor.

C. Buried Valves:
1. Clean and manually operate buried valves before installation.
2. Install valve boxes plumb and centered, with soil carefully tamped to a lateral distance of four feet on all sides of box, or to undisturbed trench face if less than four feet.
3. Set buried valves with the stem vertically aligned in the center of the valve box.
4. Before backfilling, coat all exposed portions of any bolts with two coats of bituminous paint.
5. Support the valve box during backfilling and maintain in vertical alignment with the top flush with finish grade. Set the valve box so as not to transmit traffic loads to the valve.
6. Provide flexible coupling next to each buried valve.

D. Plug Valves:
1. Install plug valves that are in horizontal liquid piping with stem horizontal and plugs on top when valve is open. Plug shall be on upstream end when valve is closed.
2. Install plug valves that are in vertical liquid piping with plug at top when closed or as recommended by valve Supplier.
3. Supplier shall tag or mark plug valves to indicate proper mounting position.

E. Tapping Sleeves and Valves
1. The proper authority shall be contacted and their permission granted prior to tapping a "live" line. The required procedures and time table shall be followed exactly.
2. Installation shall be made under pressure and flow shall be maintained. The diameters of the tap shall be not less than 1/4-in less than the inside diameter of the branch line.
3. The entire operation shall be conducted by workers experienced in the installation of tapping sleeves and valves. The tapping machine shall be furnished by the Contractor.
4. Determine the location of the line to be tapped to confirm that the proposed location will be satisfactory and that no interference will be encountered such as joints or fittings. No tap or sleeve will be made closer than three feet from a pipe joint.
5. Tapping sleeve and valve with boxes shall be set squarely centered on the line to be tapped. Adequate support shall be provided under the sleeve and valve during the tapping operation. Thrust blocks or other permanent restraint acceptable to the Construction Manager shall be provided behind all tapping sleeves. Proper tamping of supporting pipe bedding material around and under the valve and sleeve is mandatory for buried installations.
6. After completing the tap, the valve shall be flushed to ensure that the valve seat is clean. All proper regulatory procedures (including disinfection) shall be followed exactly.

F. Fire Hydrants:
1. Fire hydrants shall be set at the locations as shown on the Drawings and bedded on a firm foundation. Hydrants and connecting pipe shall have at least the same depth of cover as the distributing pipe. A drainage pit as detailed on the Drawings shall be filled with screened gravel and compacted. The hydrants shall be set upon a slab of concrete not less than 4-in thick and 15-in square. During backfilling, additional screened gravel shall be brought up around and 6-in over the drain port. Each hydrant shall be set in true vertical alignment and properly braced.
2. Connection of hydrant to isolation valve and main water line shall use restraint as presented on the Drawing details.
3. The hydrant shall be tied to the pipe with suitable rods or clamps, galvanized, painted, or otherwise rustproof treated. Hydrant paint shall be touched up as required after installation.

G. DeviceNet Installation:

1. Coordinate installation of wiring, startup schedule, and final testing and commissioning of all valve actuators with the PMCS Supplier.
2. Actuator supplier's qualified representative shall provide three days of on-site assistance specifically for DeviceNet configuration.

3.3 FIELD QUALITY CONTROL

A. Field Tests:
1. Adjust all parts and components as required to provide correct operation of valves.
2. Conduct functional field test on each valve in presence of Engineer to demonstrate that each valve operates correctly.
3. Verify satisfactory operation and controls of motor operated valves.
4. Demonstrate satisfactory opening and closing of valves at specified criteria requiring not more than 40 pounds effort on manual actuators.
5. Test ten percent of valves of each type by applying 200 pounds effort on manual operators. There shall be no damage to gear actuator or valve.
6. All testing equipment required shall be furnished by the Contractor.

3.4 MANUFACTURER'S SERVICES

A. Furnish the services of a qualified representative of the tapping equipment manufacturer to provide on-site instruction during wet tapping of the existing water mains indicated on the Drawings.

B. Provide services of qualified factory-trained service technicians to check and approve installation of valves:
1. Supplier's service technician shall perform the following:
   a. Supervise unloading of the equipment.
   b. Instruct Contractor in installing equipment.
   c. Supervise installation of equipment.
   d. Inspect and adjust equipment after installation and ensure proper operation.
   e. Instruct Owner's personnel in operating and maintaining the equipment.
2. Manufacturer's representative shall make a minimum of 4 visits, with a minimum of 4 hours onsite for each visit. First visit shall be for unloading supervision (if specified) and instruction of Contractor in installing equipment; second visit shall be for assistance in installing equipment; third visit shall be for checking completed installation and start-up of system; fourth visit shall be to instruct operations and maintenance personnel. Representative shall revisit the Site as often as necessary until installation is acceptable.
3. Training: Furnish services of Supplier's qualified factory trained specialists to instruct Owner's operations and maintenance personnel in recommended operation and maintenance of equipment.
5. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 SUPPLEMENTS

A. The supplements listed below, following "End of Section" designation, are a part of this Specification Section:
1. Table 15100-A, Schedule of Valves.

TABLE 15100-A, PROCESS AND CIVIL VALVE SCHEDULE

Valve Description	Type	Service	Size (in)	Operator	Remarks
Process Valves					
Fire Hydrant	GV	FW	5 ¼	Manual	
Water Main	GV	CW	1 ½	Manual	Valve per Liberty Water District

The following abbreviations are used in the Valves Schedule:

A. Valve Type Abbreviations

Valve Type:	Abbrev.:		Valve Type:	Abbrev.:
Ball Valve	BA		Pressure Relief Valve	PRV
Check Valve	CV		Gate Valve	GV
Plug Valve	PV		Balance Valve	BalV

B. Service Abbreviations

Service:	Abbrev.:		Service:	Abbrev.:
Biofilter Recycle	BFR		Carbon Adsorber Sample Line	SML
Screened Effluent	SCE		Fire Water	FW
Drain	DR		Fire Protection Water	FPW
Spray Water	SPW		City Water	CW
Odor Control	OC			

+ + END OF SECTION ++

SECTION 15120

COUPLINGS, ADAPTERS, AND SPECIALS FOR PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all couplings, adapters, and specials for piping.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before couplings, adapters, and specials for piping work.

C. Related Sections:
   1. Section 09900, Painting.
   2. Section 15051, Buried Piping Installation.
   3. Section 15052, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B16.39, Malleable Iron Threaded Pipe Unions.
   2. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
   3. AWWA C606, Grooved and Shouldered Joints.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer shall have at least five years experience producing substantial similar products to those specified and shall be able to provide documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain each type of coupling, adapter, and special for piping product included in this Section, regardless of component manufacturer, from a single couplings, adapters, and specials manufacturer.
   2. Supplier shall prepare, or review, and approve all submittals for components furnished under this Section.
   3. Components shall be suitable for specified service conditions and be integrated into overall assembly by the Supplier.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit piping layout Shop Drawings in accordance with Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
   2. Product Data:

a. Submit product data on each type of coupling, expansion joint, and other piping specialties and accessories, including gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
1. Certificates:
a. When requested by Engineer submit certificate attesting to compliance with standards referenced in this Section, signed by manufacturer.
2. Manufacturer's Instructions:
a. Provide instructions for handling, storing, installing, and adjusting of products.
3. Source Quality Control:
a. When requested by Engineer, submit results of source quality control tests.
4. Qualifications Statements:
a. Submit qualifications of manufacturer when requested by Engineer.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 15051, Buried Piping Installation

PART 2 – PRODUCTS

2.1 COUPLINGS

A. Sleeve-type, Flexible Couplings:
1. Pressure and Service: Same as connected piping.
2. Products and Manufacturers: Provide products of one of the following:
a. Style 253/38, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
b. No. 441/411/413, by Smith Blair, Inc.
c. Style FC Series, by Ford.
d. Or equal.
3. Material: Ductile Iron.
4. Gaskets: Suitable for specified service, as recommended by manufacturer.
5. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.
6. Harnessing:
a. Harness couplings to restrain pressure piping. For pipelines that will be under pressure, test pressures are specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
b. Tie adjacent flanges with bolts of corrosion-resistant alloy steel. Provide flange-mounted stretcher bolt plates to be designed by manufacturer, unless otherwise approved. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers.
c. On plain-end piping, for harnessing couplings, provide anchor restraint system such as Dresser Piping Specialties STAR Anchor Style 443, or equal.
d. Conform to dimensions, size, spacing, and materials for lugs, bolts, washers, and nuts as recommended by manufacturer and approved by Engineer for pipe size, wall thickness, and test pressure required. Provide minimum 5/8-inch diameter bolts.
6. Harnessing:
a. Harness couplings to restrain pressure piping. For pipelines that will be under pressure, test pressures are specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

b. Harnessing shall conform to details shown. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers.
c. On plain end piping, for harnessing couplings, provide anchor restraint system such as Dresser Piping Specialties STAR Anchor Style 443, or equal.

7. Remove pipe stop(s) if used, unless otherwise shown or specified.

B. Flanged Coupling Adapters:
1. Description: One end of adapter shall be flanged and opposite end shall have sleeve-type flexible coupling.
2. Products and Manufacturers: Provide one of the following:
a. Style 227, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
b. Style 912, by Smith Blair, Inc.
c. Or equal.
3. Pressure and Service: Same as connected piping.
4. Material: Ductile iron.
5. Gasket: Recommended by the manufacturer.
6. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and nitrided stainless nuts.
7. Harnessing:
a. Harness adapters to restrain pressure piping. For pressure pipelines, test pressures are included in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
b. For flanged adapters 12-inch diameter and smaller, provide 1/2-inch diameter (minimum) Type 316 stainless steel anchor studs installed in pressure-tight anchor boss. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by flanged adapter manufacturer. Provide the following minimum anchor studs unless otherwise approved by Engineer.
1) Six-inch Diameter and Smaller: Two
2) Eight-inch Diameter and Smaller: Four
3) Ten-inch Diameter and Smaller: Six
4) Twelve-inch Diameter and Smaller: Eight
c. For adapters larger than 12-inch diameter, provide split-ring harness clamps with minimum of four corrosion-resistant alloy steel bolts. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Harness assembly shall be as designed and recommended by flanged adapter manufacturer. Dimensions, sizes, spacing and materials shall be suitable for service and conditions encountered and shall be approved by Engineer.

7. Harnessing:
a. Harness couplings to restrain pressure piping. For pressure pipelines, test pressures are included in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
b. Harnessing shall conform to details shown. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers.

C. Split-type Grooved or Shouldered End Couplings:
1. Pressure and Service: Same as connected piping. Use shouldered end where required by pressure rating.
2. Products and Manufacturers:

a. For coupling of cast-iron or ductile iron pipe, provide products of one of the following:
   1) Style 31, as manufactured by Victaulic Company.
   2) Series 500, as manufactured by Tyler Pipe, Gustin Bacon Division.
   3) Gruvlok Figure 705, as manufactured by Grinnell Mechanical Products, division of Tyco.
   4) Or equal.
b. For coupling of standard steel pipe, where joint deflection is desired or allowed, provide products of one of the following:
   1) Style 77, as manufactured by Victaulic Company.
   2) Series 1000, as manufactured by Tyler Pipe, Gustin Bacon Division.
   3) Or equal.
c. For coupling of standard steel pipe, where joint deflection is not desired or allowed, provide products of one of the following:
   1) Style HP-70, as manufactured by Victaulic Company.
   2) Series 110, as manufactured Tyler Pipe, Gustin Bacon Division.
   3) Or equal.
d. For coupling of stainless steel pipe, provide products of one of the following:
   1) Style 77-S, as manufactured by Victaulic Company.
   2) Or equal.
e. For coupling of thermoplastic pipe, provide products of one of the following:
   1) Style 774, as manufactured by Victaulic Company.
   2) Or equal.

3. Couplings shall conform to applicable requirements of AWWA C606.
4. Housing Material:
   a. For coupling of cast-iron pipe, ductile iron pipe, steel pipe, and thermoplastic pipe: Malleable iron or ductile iron.
   b. For coupling of stainless steel pipe: Type 304 stainless steel, or equal.
   c. For coupling of aluminum pipe: Aluminum alloy 356-T6.
5. Gaskets: Recommended by the manufacturer.
6. Bolts and Nuts: Heat-treated carbon steel track bolts, plated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.

2.2 EXPANSION COUPLINGS

A. Rubber-type Expansion Couplings:
   1. General:
      a. Use rubber-type expansion couplings at all locations, except where other types are shown or specified.
   2. Manufacturers: Provide products of one of the following:
      a. Mercer Rubber Company.
      b. U.S. Rubber Supply Company, USA
      c. Or equal.
   3. Liquid Service:
      a. Construct expansion couplings of neoprene or Buna-N suitable for temperatures up to 180 degrees F.
      b. Expansion couplings shall be filled arch type. Provide backup or retaining rings as recommended by manufacturer.
      c. Expansion couplings shall be yoked in manner to provide transmission of tension loading to which expansion coupling may be subjected during system operation. Compressive or lateral movement of expansion coupling shall not be impaired by yoking system. Yoking details shall be submitted to Engineer for approval.
   5. Harnessing:

a. Where shown on Drawings, harness each expansion coupling against thrust for test pressure in piping, as specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
b. Harnessing shall be by control units consisting of two or more tie rods connected between flanges, set for maximum allowable elongation of expansion coupling.
c. Provide epoxy-coated triangular plates to connect tie rods to flanges. Tie rods shall be Series 300 stainless steel. Rubber washers shall be used between triangular plates and tie rods.
d. Provide control units in accordance with recommendations of manufacturer.

2.3 MISCELLANEOUS SPECIALTIES AND ACCESSORIES

A. Dielectric Connections:
1. General: Where copper pipe connects to steel pipe, cast-iron pipe, or ductile iron pipe, provide either dielectric union or an insulating section of rubber or plastic pipe. When used, insulating section shall have minimum length of 12 pipe diameters.
2. Manufacturers: Provide products of one of the following:
a. Epco Sales, Inc.
b. Watts Regulator Company.
c. Capitol Manufacturing Company.
d. Or equal.
3. Dielectcric Unions: Rated for 250 psi, ANSI B16.39.
4. Insulating Sections: Rated for same pressure as associated piping test pressure. Material shall be suitable for the application and service.

2.4 PAINTING

A. Shop Painting:
1. Clean and prime-coat ferrous metal surfaces of products in the manufacturer's shop in accordance with Section 09900, Painting, unless otherwise specified in this Section
2. Coat machined, polished and non-ferrous surfaces bearing surfaces and similar unpainted surfaces with corrosion prevention compound that shall be maintained during storage and until products are placed into operation.

B. Field painting shall conform to Section 09900, Painting.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect materials for defects in material and workmanship. Verify compatibility of products with pipe, fittings, valves, and appurtenances.

3.2 INSTALLATION

A. Installation:
1. Install piping specialties in accordance with the Contract Documents and manufacturer's instructions.
2. For buried installations, refer to Section 15051, Buried Piping Installation.
3. For exposed installations, refer to Section 15052, Exposed Piping Installation.

B. Adjust expansion joints as required to ensure that expansion joints will be fully extended when ambient temperature is at minimum operating temperature, and fully compressed at maximum operating temperature for the system in which expansion joints are installed.

+ + END OF SECTION + +

SECTION 15121

WALL PIPES, FLOOR PIPES, AND PIPE SLEEVES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all floor pipes, pipe sleeves, wall pipes, other wall pieces, and escutcheons to complete the Work.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate with the installation of floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons that must be installed with or within formwork, walls, partitions, ceilings and panels.

C. Related Sections:
   1. Section 03350, Cast-In-Place Concrete.
   2. Section 07920, Joint Sealants.
   3. Division 15, Sections on Piping, Valves, and Specials.

1.02 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American National Standards Institute, (ANSI).
   2. American Water Works Association, (AWWA).

1.03 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single wall pipes, floor pipes and pipe sleeves manufacturer.
   2. The wall pipes, floor pipes and pipe sleeves manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the wall pipes, floor pipes and pipe sleeves manufacturer.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:

2. Detailed drawings and data on all wall and floor pipe, and pipe sleeves. Submit and coordinate these with Shop Drawings required for all piping systems.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle all pipe sleeves in accordance with manufacturer's instruction.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Wall and Floor Pipes:
   1. Material: Same as specified for the piping connected to wall or floor pipe, unless otherwise approved by Engineer.
   2. End Connections: As shown.
   3. Thickness: Same as specified for the piping connected to wall or floor pipe.
   4. Collars: Provide collars at mid-point of wall for anchorage and watertightness.
   5. Pipes ends shall be flush with wall face, unless otherwise shown.
   6. Drill and tap flanged ends and mechanical joint bells for studs. Provide studs of same material as connected piping, except submerged and buried studs shall be of Type 316 stainless steel.

B. Pipe Sleeves:
   1. Ferrous and Plastic Pipe: Use standard weight galvanized steel pipe, unless otherwise shown.
   2. Copper Pipe: Use Type K hard drawn copper pipe, unless otherwise shown.
   3. Cast or Ductile Iron Pipe: Ductile iron furnished with integral wall collar.
   4. Dimensions: As required for mechanical joint pipe to pass through sleeve. Length as required.
   5. Provide sleeves with water collars as shown on the Drawings.

C. Link Seals:
   1. General Use: Provide link type mechanical seals of EPDM material, suitable for 20 psi working pressure, corrosive service and accessible from one side, with glass-reinforced nylon pressure plate and stainless steel bolts and nuts.
   2. Products and Manufacturers: Provide one of the following:
      a. Link-Seal Model C, as manufactured by Thunderline Corporation.
      b. Pen Seal Model ES, as manufactured by Proco Products, Inc.
      c. Or equal.
   3. 1-Hour Fire Rated Wall Penetrations: Provide link type mechanical seals of Silicone material, suitable for 20 psi working pressure, with glass-reinforced nylon pressure plate and stainless steel bolts and nuts.
      a. Products and Manufacturers: Provide one of the following:
         1) Link-Seal Model T, as manufactured by Thunderline Corporation.
         2) Pen Seal Model KS, as manufactured by Proco Products, Inc.
         3) Or equal.

4. 2-Hour and 3-Hour Fire Rated Wall Penetrations: Provide double link type mechanical seals of Silicone material, suitable for 20 psi working pressure, accessible from one side, with glass-reinforced nylon pressure plate and stainless steel bolts and nuts.
    a. Products and Manufacturers: Provide one of the following:
        1) Link-Seal Model FS, as manufactured by Thunderline Corporation.
        2) Pen Seal Model KS, as manufactured by Proco Products, Inc.
        3) Or equal.

D. Wall and Ceiling Plates:
1. Bare pipes passing through walls and ceilings in finished rooms: Provide escutcheon plates of cast brass or cast-iron nickel plated, clevis or split ring and hinged with set screws.
2. Provide plated escutcheon plates of 18-gauge steel for insulated pipes passing through walls and ceilings in finished rooms.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Wall and Floor Pipes: Install as shown and in accordance with approved Shop Drawings.

B. Pipe Sleeves:
1. Use sleeves wherever pipes pass through walls, partitions, floors, and roofs, unless otherwise shown.
2. Extend all sleeves through floor slabs a minimum of 2-inches above finished floor.
3. Anchor sleeves to concrete and masonry walls as shown or otherwise approved.
4. All sleeves through walls shall be flush with wall face.
5. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.
6. Use link type seals to seal sleeve against hydrostatic pressure. Size sleeves to provide annular space required to suit the link type mechanical seals that are used.
7. Do not install sleeves and pipes through structural members, unless specifically shown and approved by ENGINEER.
8. Size sleeves to provide annular space as follows:

Pipe Size:	Sleeve ID Minus Pipe Or Insulation OD:
Less than 2-inches	1/2-inches to 3/4-inches
2-inches to 4-inches	3/4 inches to 1-1/4-inches
6-inches to 12-inches	1-1/4 inches to 2-inches
Over 12-inches	2-inches to 3-inches

C. Install wall and ceiling plates in accordance with the manufacturer's recommendations and approved Shop Drawings.

+ + END OF SECTION + +

SECTION 15122

NON-FIRE RATED SLEEVES AND SEALS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This section describes piping and ductwork sleeves and seals required where piping and ductwork passes through non fire rated floor slabs, interior walls, and exterior wall applications.

1.02 RELATED WORK

A. Pipe, Valves, and Fittings for HVAC Systems - Section 15180

B. Firestopping for Through Penetrations – Section 07843

1.03 QUALITY ASSURANCE

A. Modular Seal components and systems shall be domestically manufactured at a plant with a current ISO-9001:2000 registration. Copy of ISO-9001:2000 registrations shall be a submittal item.

1.04 SUBMITTALS

A. Submit manufacturer's data sheets on all products. Data sheets shall include dimensions, material, temperature rating, and installation instructions.

PART 2 - PRODUCTS

2.01 INTERIOR WALL PIPE PENETRATIONS

A. For Concrete or Masonry Interior Walls:
   1. Split Wall Acoustical Seals consist of two bolted pipe halves with minimum 3/4" thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240 degrees F, 10# density fiberglass may be used in lieu of the sponge. Seals shall be type SWS as manufactured by Mason Industries, Inc.
   2. Spool Type Acoustical Pipe Seals shall consist of a closed cell neoprene sponge interior surrounded by a welded steel sleeve and flange. Concrete shall be packed around the seal to make it integral with the surface if the seal is not already in

place around the pipe prior to the construction of the building member. Caulk any residual cracks. Seals shall be type SPS as manufactured by Mason Industries Inc. or approved equal.

3. Provide a minimum 10-gauge pipe

B. For gypsum board walls:
   1. Box in round sleeve openings for pipe with No. 20 gauge galvanized sheet metal.
   2. Flange out edges of sheet metal a minimum of 1 ½ inches to secure sleeve to wall.
   3. Pack annular space between pipe and sleeve completely with mineral fiber. Recess fibrous material into sleeve 0.5 inches.
   4. Caulk openings from wall surface to pipe with nonhardening acoustical sealant both sides of wall.
   5. Seal metal sleeve to gypsum board wall.

2.02 INTERIOR WALL DUCT SLEEVES AND SEALS

A. Box in rectangular or round sleeve openings for ductwork with No. 20 gauge galvanized sheet metal. Metal sleeve to be 0.5 to 0.75 inches larger than outside dimensions of duct.

B. Flange out edges of sheet metal a minimum of 1 ½ inches to secure sleeve to wall.

C. Pack annular space between ductwork and sleeve completely with mineral fiber. Recess fibrous material into sleeve 0.5 inches.

D. Caulk openings from wall surface to duct with nonhardening acoustical sealant both sides of wall.

E. Grout metal sleeve into concrete or cmu wall or seal metal sleeve to gypsum board wall.

2.03 EXTERIOR WALL AND FLOOR PENETRATIONS

A. Furnish and install a complete Link-Seal modular seal assembly, manufactured by PSI-Thunderline/Link-Seal. For clarification, complete assembly is defined as a combined:
   1. Wall opening (i.e. steel sleeve, Thermoplastic (HDPE) sleeve, cored hole or formed hole). The wall opening size and/or type shall be selected according to recommendations found in the most recent Link-Seal modular seal catalog.
   2. Sufficient quantity and type of Link-Seal modular seals required to effectively provide a hydrostatic and/or fire-rated seal.
   3. Each individual link shall be conspicuously and permanently identified with the name of the manufacturer and model number.

B. Modular Seal Rubber Links: Shall be modular, mechanical type, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening. The elastomeric element shall be sized and selected per manufacturer's recommendations and have the following properties as designated by ASTM. Coloration shall be throughout elastomer for positive field inspection. Each link

shall have a permanent identification of the size and manufacturer's name molded into it.

1. For Standard Service Applications = Model C -40 to +250ºF (-40 to +121ºC) EPDM = ATSM D2000 M3 BA510 Color = Black
2. For Thin-Walled Pipe Applications = Model L -40 to +250ºF (-40 to +121ºC) EPDM = ATSM D2000 M3 BA510 Color = Blue
3. For Hydrocarbon Service Applications = Model O -40 to +210ºF (-40 to +99ºC) Nitrile = ASTM D2000 M1BF510 Color = Green
4. For High Temperature or Fire Seal Applications = Model T -67 to +400ºF (-55 to +204ºC) Silicone = ASTM D2000 M1GE505 Color = Gray Reference shall always be made to the latest published Link-Seal modular seal selection guide for the service intended.

C. Pressure Plates:
   1. Link-Seal modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:
      a. Izod Impact - Notched = 2.05ft-lb/in. per ASTM D256
      b. Flexural Strength @ Yield = 30,750 psi per ASTM D790
      c. Flexural Modulus = 1,124,000 psi per ASTM D790
      d. Elongation Break = 11.07% per ASTM D638
      e. Specific Gravity = 1.38 per ASTM D792
   2. Models LS200-275-300-315 shall incorporate the most current Link-Seal Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-360-400-410-425-475-500-525-575-600 shall incorporate an integral recess known as a "Hex Nut Interlock" designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer's name molded into it.
   3. For fire and Hi-Temp service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.

D. Seal Hardware: All fasteners shall be sized according to latest Link-Seal modular seal technical data. Bolts, flange hex nuts shall be either:
   1. Mild Steel with a 60,000-psi minimum tensile strength and 2-part Zinc Dichromate coating per ASTM B633 and Organic Coating, tested in accordance with ASTM B117 to pass a 1,470-hour salt spray test.
   2. 316 Stainless Steel per ASTM F593-24, with a 85,000 psi average tensile strength.

E. Wall Opening:
   1. Century-Line Sleeves - for openings to 24.81" diameter. Where pipes must pass through exterior walls of new structures, unless otherwise shown or specified, install molded non-metallic high density polyethylene Model CS Century-Line sleeves as manufactured by PSI-Thunderline/Link-Seal. Model CS sleeves shall have integrally formed hollow water stop sized having a minimum of four inches

larger than the outside diameter of the sleeve itself and allowing 1/2" movement between wall forms to resist pour forces. Each sleeve assembly shall have end caps manufactured of the same material as the sleeve itself and installed at each end of the sleeve so as to prevent deformation during the initial concrete pour, and to facilitate attaching the sleeve to the wall forms. End caps shall remain in place to protect the opening from residual debris and rodent entry prior to pipe insertion.

2. Cell-Cast Disks - for openings from 29.25" to 64.74" diameter. The contractor shall install Cell-Cast disks, providing a round hole in conformance with Link-Seal modular seal sizing data. Cell-Cast disks shall consist of 3" and/or 4" lightweight interlocking polyethylene cells stacked to form the thickness of the poured concrete wall. Molded into each cell shall be a cavity to accept a 2" x 4" nailer.

2.04 ACOUSTICAL SEALANTS

A. Acoustical sealants shall be non-hardening type.

B. Acoustical sealants shall be one of the following products:
   1. Acoustical Sealant – Tremco
   2. Approved Equal

PART 3 - EXECUTION

3.01 INSTALLATION

A. In general, the contractor shall provide sleeves at all penetrations.

B. After installation of the sleeve, completely seal around sleeve to the wall or floor material.

C. Install pipe sleeves and seals as per the manufacturer's instructions.

D. Pipe sleeves shall not support weight of the pipe. Provide pipe supports on both sides of the seal.

E. Provide escutcheon plates for all exposed penetrations.

+ + END OF SECTION + +

SECTION 15180

PIPE, VALVES AND FITTINGS FOR HVAC SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This Section describes the pipe, valves, fittings, and joining materials for use with the HVAC piping systems described in this Section and as shown on the Drawings.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 07841 - Firestopping for Through Penetrations

C. Section 15121 - Wall Pipes, Floor Pipes, and Pipe Sleeves

D. Section 15060 - Hangers and Supports for HVAC Ductwork, Piping, and Equipment

E. Section 15075 - Mechanical System Identification for HVAC Systems

F. Section 15082 - Pipe Insulation for HVAC Systems

G. Section 15184 - Piping Specialties for HVAC Systems

1.03 ABBREVIATIONS

A. The following are standard abbreviations:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene-terpolymer rubber.
   3. NRS: Nonrising stem.
   4. OS&Y: Outside screw and yoke.
   5. PTFE: Polytetrafluoroethylene plastic.
   6. SWP: Steam working pressure.
   7. TFE: Tetrafluoroethylene plastic.
   8. NPS: Nominal Pipe Size

1.04 SUBMITTALS

A. Product Data: For each type of valve indicated: Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its

application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Product data on pipe, fittings, gaskets, and bolts. Include dimensions, specifications, and manufacturer. Provide pipe and valve application schedule.

C. Provide product data, including but not be limited to dimensions, specifications, manufacturer, installation and operation instructions, temperature and pressure ratings, end connections, and required clearances on piping specialties included in this Specification.

D. Welder Certifications - Furnish the names of pipe welders and welding operators employed by the Contractor to perform the Work who have been qualified to use the welding procedures which have been qualified in accordance with the specified pressure piping codes or AWS or NFPA standards.

E. Shop Drawings
   1. Where deviations from the Drawings and Specifications are proposed for any reason, submit shop drawings identifying proposed deviations showing layout of all piping, fittings, materials, dimensions, and fabrication and installation details. Submit a comparison table of the specified features and ratings of the specified item and those of the proposed deviation to allow a direct comparison.
   2. The review of deviations will be for pressure drop only. The review will not address clearances or accessibility. No dimensional or coordination check will be made.
   3. The Contractor has the sole responsibility to review the Drawings, coordinate piping fabrication, and provide clearances and access for installation, maintenance and balancing of this Work, and Work of other trades. Unless specifically dimensioned, Drawings indicate approximate locations only. The Contractor has the sole responsibility to locate and route the piping.
   4. Submit all layout shop drawings on not less than ¼ inch equals 1 foot scale drawings.

1.05 REFERENCES

A. Division 01 - Quality Control: Requirements for references and standards.

B. AGA Z21.22 - Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems.

C. ANSI C111 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings

D. ASME B16.3 - Malleable Iron Threaded Fittings.

E. ASME B16.5 - Steel Pipe Flanges and Flanged Fittings

F. ASME B16.9 - Factory-Made Wrought Steel Buttwelding Fittings

G. ASME B16.15 - Cast Bronze Threaded Fittings

H. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

I. ASME B16.22 - Wrought Copper and Bronze Solder Joint Pressure Fittings.

J. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.

K. ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings.

L. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

M. ASME B16.39 - Pipe Unions, Malleable Iron Threaded

N. ASME-B31.1 - Power Piping.

O. ASME B31.2 - Fuel Gas Piping.

P. ASME B31.5 - Refrigeration Piping.

Q. ASME B31.9 - Building Service Piping.

R. ASME B36.10M - Welded and Seamless Wrought Steel Pipe

S. ASME SEC IV - Construction of Heating Boilers.

T. ASME SEC IX - Welding and Brazing Qualifications.

U. ASTM A47 - Ferritic Malleable Iron Castings

V. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

W. ASTM A74 - Cast Iron Soil Pipe and Fittings.

X. ASTM A105 - Forgings, Carbon Steel, for piping components.

Y. ASTM A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings

Z. ASTM A181 - Forgings, Carbon Steel, for General Purpose Piping

AA. ASTM A197 -Cupola Malleable Iron

AB. ASTM A234/A234M - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

AC. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile

AD. ASTM B32 - Solder Metal.

AE. ASTM B42 - Seamless Copper Pipe.

AF. ASTM B62 - Composition Bronze or Ounce Metal Castings

AG. ASTM B75 - Seamless Copper Tube

AH. ASTM B88 - Seamless Copper Water Tube.

AI. ASTM B306 - Copper Drainage Tube (DWV).

AJ. ASTM B584 - Copper Alloy Sand Castings for General Applications

AK. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

AL. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

AM. AWS A5.8 - Specification for Brazing Filler Material

AN. AWWA C651 - Disinfecting Water Mains.

AO. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

AP. NFPA 30 - Flammable and Combustible Liquids Code

AQ. NFPA 54 - National Fuel Gas Code.

AR. NSF 61 - Domestic Water Pipe, Valves, and Fittings.

AS. Mechanical Code of New York State-Latest Edition

AT. Plumbing Code of New York State-Latest Edition

AU. Fuel Gas Code of New York State-Latest Edition

AV. FM - Factory Mutual Compliance

AW. UL - Underwriter's Laboratory Compliance

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

D. Protect all flange faces with wood, plastic or soft metal to prevent damage to parts.

E. Protect all pipe threads from damage with plastic plugs or caps.

F. Mark and identify all piping materials in accordance with the Reference Standards specified herein.

PART 2 - PRODUCTS

2.01 GENERAL

A. When two or more valves of the same type are used in the same service, furnish all valves of this type from the same manufacturer.

B. Specific manufacturer's model numbers are cited in the following Piping Material Schedules to establish the desired quality and performance for each type valve or material. Equivalent products by other approved manufacturers are also acceptable. Approval shall be subject to review by the Engineer.

2.02 CONDENSER WATER (CWS&R, INCLUDES BLOWER COOLING WATER, WTWHP SOURCE WATER, AND ATWHP WATER)

Item	Pipe Size	Description	Manufacturer / Model No.
Piping	All sizes	Schedule 40, seamless steel, ASTM A 53 Grade B	Wheatland
Joints	2 inches & smaller 2 ½ inches & larger	Threaded Connections Welded Connections	
Fittings	2 inches & smaller 2 ½ inches & larger	150#, malleable iron, threaded, ASME B16.3 Standard Weight, Seamless steel, butt welded, ASTM A234	Anvil Weldbend
Flanges	2 ½ inches & larger	150#, forged steel, weld neck, bore to match pipe ID, ASTM A181	Weldbend
Bolts	All sizes	Alloy Steel, Hex Head Bolts and Nuts, ASTM A307 Grade B	

Item	Pipe Size	Description	Manufacturer / Model No.
Unions	2 inches & smaller	150#, malleable iron, brass trim, threaded ends ASTM A197, ASME B16.3	Anvil
Gaskets	All Sizes	Spiral wound metallic gaskets	Flexitallic Style LS/LSI
Gate Valves	2 inches & smaller	Class 125, threaded connections, rising stem, union bonnet, solid wedge, bronze body and wedge, non-asbestos packing and ductile iron hand wheel. MSS-SP80, ASTM B62	Nibco T-124
	2 ½ inches & larger	Class 125, flanged connections, OS & Y, cast-iron body and bonnet, bronze trim, solid-wedge disc, 200 psig CWP rating. ASTM A126 Class B	Nibco F-617-O
Swing Check Valves	2 inches & smaller	Class 125, Y-pattern swing type, threaded connections, bronze body with TFE seat disc. MSS-SP80, ASTM B 62	Nibco T413-Y
	2 ½ inches & larger	Class 125, swing-type, flanged connections, cast iron body with bronze trim, non asbestos gasket. MSS-SP71, ASTM A126 Class B	Nibco F918-B
Ball Valves	2 inches & smaller	Two-Piece, full-Port, threaded connections, bronze body, chrome-plated brass/bronze ball, TFE seats, separate packnut with adjustable stem packing, anti-blowout stem, 150 psig SWP and 600-psig CWP ratings. MSS SP-110, ASTM B584 Alloy C84400	Nibco T-585-70
Butterfly Valves	2 ½ inches & larger	Full-lug type with ductile-iron body, one-piece Type 416 stainless-steel stem, copper bushing, aluminum-bronze disc, and molded-in EPDM seat. Valve sizes 2 ½" through 6" shall have lever lock operator; valve sizes 8" and larger shall have weatherproof gear operator. MSS SP-67	Nibco LD-2000-3/5

Item	Pipe Size	Description	Manufacturer / Model No.
Balancing Valves	2 inches & smaller	Provide ball or globe style with flow balancing and shut-off capabilities, memory stops, and minimum two metering ports. Female sweat, NPT threaded, or press connections to match system piping. Bronze, brass or steel construction consistent with system temperature and pressure. Minimum design operating pressure of 175 psig. Provide with upstream strainer.	Armstong CBV B&G Circuit Setter IMI STAS/STAD
Balancing Valves	2 ½ inches & larger	Valve shall be of cast iron construction with 125 psi ANSI flanged connections suitable up to 175 psi working pressure. Valves 2-1/2"-3" pipe shall have a brass ball with glass and carbon filled TFE seat rings. Valves 4"-12" shall be fitted with a bronze seat, replaceable bronze disc with EPDM seal insert, and stainless steel stem. Valves to have memory stop feature to allow valve to be closed for service and then reopened to set point without disturbing balance position. All valves to have calibrated nameplate to assure specific valve setting. Valves to be leak-tight at full rated working pressure. Design pressure and temperature shall be 175 psig at 250 deg F. Provide with upstream strainer.	Bell and Gossett Circuit Setter

2.03 HEATING HOT WATER PIPING

Item	Pipe Size	Description	Manufacturer / Model No.
Pipe	2 inches and smaller	Type L, hard drawn copper tubing, ASTM B88	Mueller Industries Wheatland
	2 ½ inches and larger	Schedule 40, seamless steel, ASTM A 53 Grade B	

Item	Pipe Size	Description	Manufacturer / Model No.
Joints	2 inches and smaller 2 ½ inches and larger	Lead-free solder, ASME B32; Water Soluble Flux, ASTM B-813 Welded Connections	J.W. Harris-Bridgit
Fittings	2 inches and smaller 2 ½ inches and larger	Cast copper alloy or wrought copper ASME B16.18 or ASME B16.22 Standard Weight, Seamless steel, butt welded, ASTM A234	Nibco Weldbend
Flanges	2 ½ inches and larger	150#, forged steel, weld neck, bore to match pipe ID, ASTM A181	Weldbend
Bolts	All sizes	Alloy Steel, Hex Head Bolts and Nuts, ASTM A307 Grade B	
Unions	2 inches & smaller	Wrought copper, solder unions, ASME B16.22	Nibco
Dielectric Unions	2 1/2 inches & smaller	Dielectric Type, Copper to Steel	Watts Regulator Series 3000
Gaskets	All Sizes	Spiral wound metallic gaskets	Flexitallic Style LS/LSI
Ball Valves	2 inches & smaller	Two-piece, full-port, soldered ends, bronze body, type 316 stainless-steel vented ball and stem, reinforced TFE seats, 150 psig SWP and 600-psig CWP ratings. MSS SP-110, ASTM B 584 Alloy C84400, ASME B1.20.1	Nibco S-585-70-66
Check Valves	2 inches & smaller 2 ½ inches & larger	Class 125, Y-pattern swing type, soldered connections, bronze body with TFE seat disc. MSS-SP80, ASTM B 62 Class 125, swing-type, flanged connections, cast iron body with bronze trim, non asbestos gasket. MSS-SP71, ASTM A-126 Class B	Nibco S413-Y Nibco F918-B

Item	Pipe Size	Description	Manufacturer / Model No.
Butterfly Valves	2 ½ inches & larger	Full-lug type with ductile-iron body, one-piece Type 416 stainless-steel stem, copper bushing, aluminum-bronze disc, and molded-in EPDM seat. Valve sizes 2 ½" through 6" shall have lever lock operator; valve sizes 8" and larger shall have weatherproof gear operator. MSS SP-67	Nibco LD-2000-3/5
Balancing Valves	2 inches & smaller	Provide ball or globe style with flow balancing and shut-off capabilities, memory stops, and minimum two metering ports. Female sweat, NPT threaded, or press connections to match system piping. Bronze, brass or steel construction consistent with system temperature and pressure. Minimum design pressure and temperature shall be 175 psig at 250 deg F. Provide with upstream strainer.	Armstrong CBV B&G Circuit Setter IMI STAS/ATAD
Balancing Valves	2 ½ inches & larger	Valve shall be of cast iron construction with 125 psi ANSI flanged connections suitable up to 175 psi working pressure. Valves 2-1/2"-3" pipe shall have a brass ball with glass and carbon filled TFE seat rings. Valves 4"-12" shall be fitted with a bronze seat, replaceable bronze disc with EPDM seal insert, and stainless steel stem. Valves to have memory stop feature to allow valve to be closed for service and then reopened to set point without disturbing balance position. All valves to have calibrated nameplate to assure specific valve setting. Valves to be leak-tight at full rated working pressure. Design pressure and temperature shall be 175 psig at 250 deg F. Provide with upstream strainer.	Bell and Gosset Circuit Setter

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Unless otherwise shown, route piping in the most direct manner parallel to building lines in accordance with the Drawings. Group piping whenever practical at common elevations.

B. Accurately align, support and connect piping without forcing.

C. Locate piping so that access to and clearance around equipment, and minimum piping headroom of 6'-8" is maintained, except where otherwise shown.

D. Space piping so that insulation and flanges, if any, have at least 1 inch clearance after maximum movement.

E. Where pipe elevations are not shown, pitch supply and return lines to positive drain points and/or coils.

F. Provide accessible flanges or union connections on the supply and return connections of terminal equipment and other items which must be disconnected for maintenance. Where unions are furnished as an integral part of the equipment, additional unions are not required unless required for access to or removal of components. Arrange equipment piping connections so that maintenance can be made without removing large sections of pipe or relocating the equipment.

G. Connect branch lines to the bottom or lower half of the line, preferably the bottom.

H. Use fittings for all changes of direction. Bending of steel pipe is not permissible.

I. Clean all piping materials before installation to remove grease, loose dirt, mill scale and other foreign matter.

J. Provide air vents at all high points of water piping, and valved drains at all low points of water piping for complete venting, draining and flushing of the piping system. Locate and provide air vents at multiple high points that are necessary to prevent air binding in the piping system. Install additional air vents and drains if directed by the Engineer, at no cost to the Owner. As a minimum provide drains and air vents
   1. In each section of piping separated by valves.
   2. On all coils.
   3. For each riser, where riser or runout to riser has a valve installed.
   4. In low point of piping to each down fed convector or radiator.

K. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Provide loops, pipe offsets and anchors.

L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

M. Install gate or ball valves for shut-off and to isolate equipment, parts of systems, or vertical risers.

N. Sleeve pipes passing through partitions, walls and floors.

O. Identify piping under provisions of "Mechanical System Identification" Specification.

P. Provide escutcheons at all locations where piping installed exposed to view penetrates wall, partitions, floors and ceilings.

Q. Install flexible connectors at inlet and discharge connections of pumps and other vibration producing equipment.

R. Install strainers on the supply side of each control valve, pressure regulating valve, solenoid valve, trap, and elsewhere as indicated.

S. For pressurized liquid piping systems installed horizontally make reductions in pipe sizes using eccentric reducer fitting installed with the level side up to allow air venting.

T. For all nipples up to and including six inches in length provide extra-heavy shoulder type. For all nipples over six inches in length provide corresponding material, quality and thickness as the pipe on which they are used. Do not use close nipples. Provide nipples with designation mark of the manufacturer conforming to the ASTM pipe specifications for system served.

U. Make connections to all cooling and heating units with single or multiple cooling or heating coils in accordance with the manufacturer's instructions and labeling on equipment

V. For pressures over 15 psig, use nipples and caps instead of plugs for permanent closures. Plugs in equipment provided by equipment manufacturers are acceptable.

W. Do not install piping above electrical panels. Route piping around panels.

3.02 THREADED CONNECTIONS

A. Ream pipe ends to remove burrs.

B. Use only standard ANSI taper threads. Threads shall be full, sharp, clean, and free of fins and burrs.

C. Apply joint sealing tape or paste to male threads only. Do not use paste on compressed air lines. When sealing fuel oil piping, use a thread-sealing compound suitable for oil when making up joints. When sealing natural gas piping, use a thread-sealing compound suitable for natural gas when making up joints.

D. Do not use close or short nipples of a size where the length of unthreaded pipe is less than the width of a pipe wrench.

E. Thredolets or similar code-approved fittings may be used for branch connections.

F. Provide unions at all threaded valve locations to facilitate the removal of the valve.

G. Joint Sealing Compound; Hercules, RectorSeal or approved equal.

3.03 WELDED CARBON STEEL CONNECTIONS

A. Perform welding using qualified welders and procedures following specified reference standards.

B. Do not use mitered welds for elbows.

C. Welded branch connections may be used in place of welding tees provided that requirements of the applicable ASME Code for pressure piping, B31.1 and/or B31.9 are met.

D. Weldolets or similar code-approved fittings may be used for branch connections.

E. Qualifications of welders, welding procedures, performance of welders and welding operators are required complying with the requirements of ASME B31.9 and ASME Boiler and Pressure Vessel Code, Section IX. Keep records and certifications required by code on file and available for inspection.

F. Whenever welding is done close to walls, floors or building structure, thoroughly clean the surfaces of weld splatter. Remove weld splatter from the surface of all welds, pipe and pipe supports.

G. Provide long radius pattern for welding elbows unless otherwise shown on the Drawings.

H. Examine and inspect welded pipe joints as follows:
   1. Visually examine all welded pipe joints for imperfections using qualified representatives. Submit qualifications to the Architect/Engineer.
   2. Make available to the Architect/Engineer records of visual examinations upon request.
   3. Remove weld defects by grinding or chipping and repair or replace joints in accordance with approved procedures.
   4. Make shop and field welded joints available to the Owner for nondestructive inspection and examination upon request.

3.04 FLANGED CONNECTIONS

A. Arrange flange bolt holes to straddle the pipe vertical and horizontal centerlines, and match the orientation of mating flanges.

B. Install piping to equipment without strain.

C. Provide gaskets at all flanged connections suitable for the design and temperature of the fluid contained, and in accordance with Part 2 of this Section.

D. Mate flat face flanges together and raised face flanges together.

3.05 COPPER TUBING CONNECTIONS

A. Provide soldered or brazed in accordance with Part 2 of this Section.

B. Make soldered and brazed connections in accordance with the procedures in the current edition of the Copper Tube Handbook of the Copper Development Association.

C. Qualifications of brazers, brazing procedures, and performance of brazers and brazing operators are required in compliance with the requirements of ASME B31.1, ASME B31.9, and the Boiler and Pressure Vessel Code, Section IX. Keep records and certifications required by the code on file and available for inspection.

D. Make solder joints on all copper water piping with 95/5 solder. Absolutely no lead-based solder will be accepted.

E. Clean joints thoroughly before soldering.

F. Remove excess solder and flux with a cloth or brush to leave a uniform clean fillet.

G. For refrigeration copper tubing connections, comply with ASME B31.5. Make brazed joints on all refrigeration piping.

3.06 CONNECTIONS OF DISSIMILAR METALLIC MATERIALS

A. Isolate connections between dissimilar metallic materials using dielectric connections. Use dielectric unions or flanges that provide a complete isolation of the two ends, including bolts for flanges, using materials suitable for the design pressure, temperature and fluid contained.

3.07 VALVES

A. Provide valves of the same size as the pipe in which they are installed, unless shown otherwise on the Drawings. At pumps, match valve size to pipe size and not pump connection size.

B. Install valves with the stem on or above the horizontal. Install valves with the stem horizontal if requirements of headroom, access or chain operation must be met.

C. Pack valves and adjust glands before final acceptance.

D. Install valve extension stems or chain operators where the center of valve hand wheels is more than 6 feet-6 inches above the floor and valve is 2 ½" and larger. Prove chain hooks where required to prevent fouling of chains on equipment and to clear walkways.

Terminate chains approximately 3 feet-6 inches above the floor. Provide worm gear operators or impact hand wheels for all valves 6 inches and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation and a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation.

F. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

G. Locate valves for easy access and provide separate support where necessary.

H. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb

I. Install butterfly valves with stems horizontal to allow support for the disc and the cleaning action of the disc.

J. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

K. Install balancing valves with lengths of straight pipe upstream and downstream of valve as per manufacturer's instructions such that calibrated accuracy is maintained As a minimum provide straight lengths as per the following table;

REQUIRED STRAIGHT LENGTHS

Valve Size	**Upstream (In Pipe Diameters)**	**Downstream (In Pipe Diameters)**
½"-3"	3	1
4"-12"	5	2

L. Chain wheel Actuators- Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Sprocket rim with Chain guides: Ductile Iron (Aluminum for applications exposed to weather), of type and size required for valve.
   2. Brackets: Type, number, size, and fasteners required to securely mount actuator on valve.
   3. Chain: Stainless steel, of size required to fit sprocket rim.
   4. Manufacturers:
      a. Babbitt Steam Specialty Co.
      b. Roto Hammer Industries
      c. Approved equal

3.08 CONTROL VALVE INSTALLATION

A. Install all control valves so that the stem position is not more than 60 degrees from the vertical up position.

B. Install valves in accordance with the manufacturer's recommendations.

C. Install control valves so that they are accessible and serviceable, and such that actuators may be serviced and removed without interference from structure or other pipes, ducts and/or equipment.

D. Install isolation valves at control valves such that control valve body may be serviced without draining the supply/return side piping system. Install unions at all connections to screwed type control valves.

3.09 PRESSURE TESTING, FLUSHING AND CLEANING

A. Pressure test piping systems in accordance with applicable codes and as described herein.

B. Pressure testing - Schedule pressure testing so that it may be witnessed by the Engineer, Owner, or their representative. Perform tests in accordance with the following procedures:
   1. Before testing, complete the installation of each pipe line, including final supports, hangers and anchors. Perform testing before insulation or paint is applied for examination during the test. Clean piping and equipment of metal cuttings and foreign matter as they are installed.
   2. Codes - Pressure test piping to assure integrity of material and workmanship in accordance with the applicable ASME Code for pressure piping (B31) and New York State Code.
   3. Protection of Equipment - Protect equipment, instruments and piping specialties which are not included in the test by either disconnecting from the piping and blanking off the end of the pipe with a blind flange, plug or cap, or isolating by insertion of a line blind or spool piece as required. Disconnect pneumatic control lines and close all openings.
   4. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   5. Piping may be tested in sections or circuits as required for the progress of the work.
   6. Provide all systems to be pressurized with the appropriate gauges, certified calibrated by the manufacturer, and pressure-relieving devices.
   7. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test. Do not allow test pressure to exceed maximum pressure for any vessel, pump, valve, or other component in system under test.

8. Records - Provide records of all tests showing line designation, test pressure, ambient temperature, date of test, retests and signature of witness.

C. Hydrostatic Test Procedures - Perform hydrostatic testing in accordance with ASME B31.9.
   1. Perform test using the pressure indicated under "Pressure Testing Schedule"
   2. After hydrostatic test pressure has been applied for at least two hours, examine piping, joints, and connections for leakage while maintaining test pressure. Repeat hydrostatic test until there are no leaks.
   3. Repair leaks as specified under "Repair of Line Leaks"

D. Service Testing - Perform service testing in accordance with ASME B31.9.
   1. For gases and steam and condensate service not over 15 psig, and for nontoxic, noncombustible, nonflammable liquids at pressures not over 100 psig and temperatures not over 200 degrees F a system test with the service fluid is acceptable. This exemption does not apply to natural gas piping.
   2. Bring the piping system up to operating pressure gradually with visual examination at a pressure between one-half and two-thirds of design pressure. Make a final examination at operating pressure.
   3. Repair leaks as specified under "Repair of Line Leaks"
   4. Repeat service test until there are no leaks.

E. Repair of Line Leaks - Comply with the following procedures for repair of leaks. In each case retest after repairs are made.
   1. Soldered/Brazed Joints - Remove solder/brazing alloy and reapply with proper flux.
   2. Flanged Joints - Check to determine flange end alignment and that all bolts are uniformly tightened with the required torque. If leak persists, depressurize the line, remove gasket, examine flange end face, and insert new gasket.
   3. Threaded Joints - Tighten joint to a required torque. If leak does not stop, replace pipe and/or fittings. Do not use pipe dope, cement or seal weld to stop pipe leaks.
   4. Gasketed Joints - Remove existing gasket and insert new gasket.
   5. Welded Steel Joints - Repair pipe in accordance with applicable ASME B31 code.
   6. Leaks in Material - Leaks located in pipe or fitting material require the replacement of that section of pipe or fitting and a repeat of the entire system using the complete procedure required for that system. Caulking, welding or epoxy is not permitted. Repair all damage caused by leaks.

F. Flushing - Complete pressure testing requirements prior to flushing. Performance of the flushing may be witnessed by the Engineer, Owner, or their representative, provide ample notification to all parties in advance of flushing any system. Perform system flushing in accordance with the following procedures:
   1. Flush all main and branch steam and liquid piping systems after pressure testing is complete with new potable water while draining the system at all low points. Isolate all connected equipment and flush individually.

2. Flushing for piping and equipment will be considered complete when water samples taken at all low points indicate clear discharge-with no visible solids. If not clear, continue flushing and sampling until discharge is clear.

G. Cleaning - Complete flushing requirements prior to cleaning. Performance of the cleaning may be witnessed by the Engineer, Owner, or their representative, provide ample notification to all parties in advance of cleaning any system. Perform system cleaning in accordance with the following procedures:
   1. Clean hot water/chilled water lines as described below:
      a. When flushing discharge is clear, fill piping systems with water and sufficient approved alkaline cleaning material to remove dirt, oil and grease. Include all connected equipment in the cleaning.
      b. Vent system and place in operation, with automatic controls operating at set point temperature or an operating temperature designated by the Engineer. Circulate the solution through the system for a minimum of 4 consecutive hours.
      c. After 4 hours, drain system and flush with clean water until the pH at the farthest drain matches the clean water input. Keep strainers unplugged during the cleaning operations. Refill system with clean water.
   2. Clean temporary pump strainers and strainers at coils, etc. every 2 hours periodically during cleaning procedures. Do not remove temporary strainers until all cleaning steps are completed and the operation of the system indicates that the system is free of all foreign matter.
   3. Blow out all piping and equipment after cleaning and final flushing is completed and the system is drained with clean dry instrument air for a minimum of 15 minutes or until all water is expelled from the system. Upon completion seal the system by closing all drains and vents.
   4. Following the Engineer approval of the above flushing and cleaning procedures, immediately fill each system and chemically treat and monitor in accordance with the "Chemical Treatment Systems" specifications.

H. Pressure Testing Schedule:

Service	Test Type	Design Operating Pressure (psig)	Test Pressure (psig)
Condenser Water Supply & Return	Hydrostatic		1.5 times maximum working pressure, but not less than 100 psi
Heating Hot Water Supply & Return	Hydrostatic		1.5 times maximum working pressure, but not less than 100 psi

+ + END OF SECTION + +

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SECTION 15181

CONDENSATE DRAIN PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Condensate Drain Piping.

1.02 RELATED SECTIONS

A. Section 15060 - Hangers and Supports for HVAC Ductwork, Piping, and Equipment

B. Section 15075 - Mechanical System Identification for HVAC Systems

C. Section 15082 - Piping Insulation for HVAC Systems

1.03 REFERENCES

A. Section 014500 - Quality Control: Requirements for references and standards.

B. ASTM D1784 - Rigid Vinyl Compounds.

C. ASTM D1785 - PVC Plastic Pipe, Schedule 40

D. ASTM D2466 - PVC Plastic Fittings, Schedule 40

E. ASTM D2665 - PVC Drain, Waste, and Vent Pipe and Fittings

F. ASTM D2564 - Solvent Cements for PVC Pipe and Fittings

G. ASTM D2321 - Underground Installation of Thermoplastic Pipe (non-pressure applications)

H. ASTM F1668 - Procedures for Buried Plastic Pipe

I. ASTM F1866 - Fabricated PVC DWV Fittings

J. NSF Standard 14 - Plastic Piping Components and Related Materials.

K. NSF Standard 61 - Drinking Water System Components - Health Effects.

1.04 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals: Procedures for submittals.

B. Product Data: Provide data on pipe materials, pipe fittings, and accessories. Provide manufacturers catalog information.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with County requirements.

B. Identify pipe with marking including size, ASTM material classification and ASTM specification.

1.06 REGULATORY REQUIREMENTS

A. Perform Work in accordance with New York State Building Code, Mechanical Code, and Plumbing Code requirements.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Section 01610 - Transportation and Handling of Materials and Equipment

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Section 01560 - Environmental Controls

PART 2 - PRODUCTS

2.01 CONDENSATE DRAIN PIPING (DIAMETER LESS THAN OR EQUAL TO 1-INCH)

A. Copper Type L Pipe and Fitting System.

B. Pipe and fittings shall be manufactured from Type L Copper.

C. Pipe and fittings shall be manufactured as a system and be the product of one manufacturer.

D. Pipe and fittings shall conform to National Sanitation Foundation (NSF) Standard 61 or the health effects portion of NSF Standard 14.

E. Testing with or transport/storage of compressed air or gas in Copper pipe or fittings shall not be permitted.

F. The system is intended for pressure drainage applications where the temperature will not exceed 140°F.

2.02 CONDENSATE DRAIN PIPING (DIAMETER GREATER THAN 1-INCH)

A. Type L copper solid wall pipe and type L copper fitting system.

B. Pipe and fittings shall be manufactured as a system and be the product of one manufacturer.

C. Pipe and fittings shall conform to National Sanitation Foundation (NSF) Standard 14.

D. Testing with or transport/storage of compressed air or gas in copper pipe or fittings shall not be permitted.

E. The system is intended for non-pressure drainage applications where the temperature will not exceed 140°F.

2.03 PVC SCHEDULE 40 SOLID WALL PIPE AND PVC DWV FITTING SYSTEM.

A. Pipe and fittings shall be manufactured from virgin rigid PVC (polyvinyl chloride) vinyl compounds with a Cell Class of 12454 per ASTM D1784.

B. PVC Schedule 40 pipe shall be iron pipe size (IPS) conforming to ASTM D1785 and ASTM D2665.

C. Injection molded PVC DWV fittings shall conform to ASTM D2665. Fabricated PVC DWV fittings shall conform to ASTM F1866.

D. Pipe and fittings shall be manufactured as a system and be the product of one manufacturer.

E. Pipe and fittings shall conform to National Sanitation Foundation (NSF) Standard 14.

F. Testing with or transport/storage of compressed air or gas in PVC pipe or fittings shall not be permitted.

G. Buried pipe shall be installed in accordance with ASTM D2321 and ASTM F1668.

H. Solvent cement joints shall be made in a two step process with primer manufactured for thermoplastic piping systems and solvent cement conforming to ASTM D2564.

I. Primer shall conform to ASTM F656.

J. The system shall be protected from chemical agents, fire stopping materials, thread sealant, plasticized vinyl products, or other aggressive chemical agents not compatible with PVC compounds.

K. The system is intended for non-pressure drainage applications where the temperature will not exceed 140°F.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor shall verify all existing conditions before starting work.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions and the requirements of the Plumbing Code of New York State.

B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls. Effect changes in size with reducing fittings.

C. Install piping to maintain headroom, conserve space, and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to fittings.

F. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with general construction.

G. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

H. Sleeve pipes passing through partitions, walls and floors.

I. Identify piping under provisions of Section 15075.

3.04 APPLICATION

A. Install unions downstream at equipment or apparatus connections.

3.05 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to ¼ inch per foot minimum. Maintain gradients.

3.06 FIELD QUALITY CONTROL

A. Drainage System: Test plug all system openings with the exception of the system's highest point. Fill system with water to the point of overflow and subject the highest point to 10-foot head of water. The system shall be considered tight if the pressure is held for not less than 30 minutes without signs of leakage.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 15182

THERMOMETERS AND PRESSURE GAUGES FOR HVAC SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This section describes the thermometers and pressure gauges for monitoring liquid water in mechanical HVAC equipment and HVAC systems to be provided as part of the Work.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's catalog sheets and specifications.

B. Certification - Submit certified accuracy for all products specified.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Subject to compliance with the specifications, provide products from the following manufacturers.
   1. Weksler Instruments
   2. H.O. Trerice Co.
   3. Taylor Instrument Co.
   4. Moeller Instrument Co.

2.02 THERMOMETERS FOR MEASURING LIQUID TEMPERATURE

A. Thermometer Scale Ranges: Provide thermometers, with scale range 1-1/2 times the actual working temperature required for the particular application, as approved. Provide maximum of 2 degrees between graduations and 10 degrees between numerals.

B. Thermometers: Provide red reading or magnified column industrial type, with wide angle of vision. Thermometers containing mercury are not permitted. Design and materials as follows:
   1. Case: Heavy one piece cast aluminum or extruded brass construction, with a clear acrylic plastic or glass lens. (Adjustable Angle)
   2. Scale: White enamel background with bold black figures and graduations. Provide 7 inch scale length for installation in piping and 9 inch length for installation in tanks and similar equipment.
   3. Separable Thermowell: Provide thermometers with matching brass separable socket thermometer wells in accordance with manufacturer’s recommendations.
   4. Stem: Swivel neck design.

5. Locking Device: Adjustable case locknut and adjusting screw function independently to provide full 360 degree positioning of thermometer case and stem to provide optimal visibility.

2.03 PRESSURE GAUGES

A. Provide pressure gauges with 4½" dial size with a flangeless stainless steel case, stainless steel friction ring and acrylic window. Provide brass movement with a bronze bourdon tube and brass socket.

B. Dial face: white with black figures; pointer with zero adjustment screw.

C. Accuracy: ±1% of scale range, ASME B40.1 Grade 1A.

D. Approved manufacturers: Trerice No. 620 or approved equal.

E. Provide stainless steel needle valves for all pressure gauges, Trerice or approved equal.

F. Provide pressure snubbers for gauges on any service where pressure surges or pulsations are possible, Trerice No. 872 or approved equal.

2.04 COMBINATION PRESSURE/TEMPERATURE TEST STATIONS

A. Provide test stations where shown on the Drawings.

B. Test stations: “Pete’s Plug II”, 1/4” solid brass fitting to receive either a 1/8” OD temperature or pressure probe with two valve cores of Neoprene (Max 200°F at 500 PSI), or Nordel (Max 275°F at 500 PSI). Provide fitting with a color coded cap strap with gasket, rated at 1000 PSI at 140°F. Provide material compatible with piping system that test station is installed in as per manufacturer’s recommendations.

C. When installed in insulated lines, test connection provide Pete’s XL plug, extended stem type.

D. Supply to the Owner, upon completion of the Work, a pressure and temperature test kit consisting of a 0-100 PSI, 0-230 ft. of water pressure gauge with a Number 500 gauge adapter attached,. one 25-125°F and one 0-220°F pocket testing thermometer, an extra number 500 gauge adapter, and a protective carrying case.

E. Approved Manufacturer: - Pete’s Plug II by Peterson Equipment.

2.05 RANGES FOR TEMPERATURE AND PRESSURE GAUGES

Thermometer	Hot Water	60° to 240°F
Pressure Gauges	Hot Water	0 to 60 psig
Thermometer	Condenser Water	30° to 130°F
Pressure Gauges	Condenser Water	0 to 60 psig

Note: Select the proper range so that the average operating pressure and temperature falls approximately in the middle of the scale selected. It is the Contractor's responsibility to determine the average operating range and select the scale appropriately, using the above table as an approximate guide.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Thermometers:
   1. Install thermometers, of type and scale range as required for the particular application, at locations indicated on the Drawings or as required by the Specifications.
   2. Install thermometers of type, scale range, and with case style, as required for the particular application, at locations indicated on the Drawings or Specified. Angle each thermometer so that it can be easily read from a standing position at floor level.
   3. Where thermometers are installed in piping with insulation 2 inches thick or greater, provide thermometer wells with extension necks. Omit extension necks where thermometers are used on bare pipe or pipe with insulation less than 2 inches thick.
   4. Where thermometer wells are installed in piping 2 ½ inches and smaller, increase the pipe size by a minimum of one pipe diameter to avoid restricting the flow in the pipe or install thermometers at elbows such that the stems protrude into the flowing medium.

B. Pressure Gauges:
   1. Install gages, of type and scale range as required for the particular application, at locations indicated on the Drawings or as required by the Specifications.
   2. For measuring liquid pressure, install gauges complete with stop cocks and drain cocks.

C. Pressure Snubbers:
   1. Install pressure snubbers in the piping connections to all gages installed in the suction and discharge piping connections to pumps.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 15183

HYDRONIC SPECIALTIES FOR HVAC SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This Section describes the hydronic specialties for hydronic heating and cooling piping including, but not limited, to the following systems:
   1. Expansion Tanks
   2. Air and Dirt Separators
   3. Buffer Tanks
   4. Suction Diffusers
   5. Water Hammer Arrestors

1.02 REFERENCES

A. ASME - Boilers and Pressure Vessel Codes, SEC 8-D-Rules for Construction of Pressure Vessels.

1.03 SUBMITTALS

A. Product Data: Provide product data for manufactured products and assemblies required for the Work. Include component sizes, rough-in requirements, service sizes and finishes. Include product description, model and dimensions.

B. Submit manufacturer's instructions for maintenance and repair.

C. Provide a valve and specialty application schedule.

1.04 OPERATION AND MAINTENANCE DATA

A. Maintenance Data: Include installation instructions, assembly views, lubrication instructions and replacement parts list.

1.05 RELATED WORK

A. Section 15180 - Pipe, Valves and Fittings for HVAC Systems

1.06 QUALIFICATIONS

A. Companies specializing in making products specified with at least 5 years of experience and products that have been on the market for at least 3 years.

PART 2 - PRODUCTS

2.01 ASME BLADDER TYPE EXPANSION TANKS

A. Manufacturers:
   1. Taco
   2. Bell & Gossett
   3. Armstrong
   4. Approved equal.

B. Construction: Welded steel, designed, tested and stamped in accordance with ASME (BPV code sec VIII, div 1); supplied with National Board Form U-1, rated for working pressure of 125 psi , with flexible seamless heavy duty butyl rubber bladder. All wetted components to be fabricated of FDA approved materials. Bladder shall be able to accept the partial volume of the expansion tank and shall be removable and replaceable. The bladder shall be connected to the top of the tank via a hose/tube that with distribution holes that facilitate even expansion of the bladder.

C. System connection shall be via a ½ inch 304 stainless steel NPT connection on the top of the tank. A Schrader valve fitting shall be installed at the top of the tank to allow external pressurization of the bladder. Valve shall be protected by a 1½ "coupling welded to the tank.

D. Accessories: Pressure gage (field installed in adjacent piping by others) and air-charging fitting; precharge to pressure indicated on plans.

2.02 AIR AND DIRT SEPARATORS

A. Manufacturers:
   1. Taco
   2. Bell & Gossett
   3. Armstrong
   4. Approved equal.

B. Air and dirt removal device shall be constructed of steel. It shall be designed, fabricated and stamped per ASME Section VIII Division 1 with a maximum working pressure of 125 psi at 270°F/. Manufacturer shall be holder of ASME U stamp.

C. Units up to three 3-inch in size shall be provided with threaded connections as standard. Units four 4-inch and larger shall be provided with flanged system connections as standard. Inlet and outlet connections to be inline with piping system. Both inlet and outlet to be in the same horizontal and vertical planes.

D. Each air and dirt removal device shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly. The air vent shall be able to be closed to allow flushing and purging of dirt via side port without dirt passing through vent on initial system fill.

E. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and removal of the floating impurities from the air system interface within the separator.

F. A blow down valve shall be provided by the unit manufacturer on the bottom of each unit to allow blow down and cleaning. On units 2 ½" and smaller the valve and all of its fittings shall be 1". On units three 3" and larger the valve and all openings shall be 2".

G. The air and dirt removal device shall remove air down to 18 microns and shall remove dirt/debris down to 35 microns. The unit shall be 100% efficient at removing dirt down to 90 microns in 100 passes or less.

H. The air and dirt separator shall employ the use of high surface area pall rings to achieve optimal separation of air and dirt with minimal pressure drop. The pall rings shall be made of stainless steel.

I. Manufacturer must have at least 15 years of experience with microbubble coalescing and dirt removal technology.

J. The unit shall be manufactured with a removable cover to facilitate removal, inspection, and cleaning of the pall ring basket. The entire pall ring basket shall be constructed of stainless steel. For safety and ease of service the unit shall be accessed from the top and the pall ring basket shall be accessed as one complete assembly housed in a stainless steel cage.

2.03 VERTICAL BUFFER TANKS

A. Buffer tanks shall be carbon steel tanks designed and constructed for design pressure 125 psig and 240°F as per ASME Code Section VIII and shall have an ASME nameplate affixed to the tank.

B. Tank dimensions and system taps/connections shall be as shown on the HVAC Details and as called for on the Equipment Schedules.

C. Tanks shall include air vent at top of tank and drain valve at bottom of tank.

D. Tanks shall have welded base ring and welded lifting lugs for rigging.

E. Acceptable manufacturers include Thermal Leverage, Niles Steel Tank, and TACO.

2.04 SUCTION DIFFUSERS

A. Furnish and install as shown on the Drawings, angle pattern flow straightening fitting equipped with a combination diffuser strainer-orifice cylinder, flow straightening vanes, start-up strainer and adjustable support foot. Design the combination diffuser-strainer-orifice cylinder to withstand pressure differential equal to the system pump shutoff head with a free area equal to five times the cross section area of the pump suction opening. Provide flow straightening vanes no less than 2 1/2 times the diameter of the system pump suction connection in length.

B. Cast Iron NPT and Flanged Models Rated for a Maximum Working Pressure of 175 PSIG.

C. 2” and smaller: Cast iron flow straightening fitting with NPT system and NPT pump connections.

D. 2 1/2” and larger: Cast iron flow straightening fitting with flanged system and flanged pump connections.

E. Stainless steel combination diffuser-strainer-orifice cylinder with 3/16" diameter perforations to protect the system pump. Full length stainless steel flow straightening vanes to provide nonturbulent flow to the suction side of the system pump. Bronze start-up strainer with 16 mesh. Construct so that all internal components are replaceable.

F. Suction diffusers shall be provided by the same Vendor as the Pumps on which they are used.

2.05 WATER HAMMER ARRESTORS

A. ANSI A112.26.1; stainless steel shock absorber, piston type sized in accordance with PDI WH-201, precharged suitable for operation in temperature range 34 to 250 degrees F and maximum 150 psi working pressure.

B. Install water hammer arrestor in the upright position as close as possible to the valve being served at locations shown on the Drawings and at all solenoid, remote operated or quick closing valves.

C. Approved Model: J. R. Smith 5000 series “Hydrotrol” or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer’s instructions and as shown on the Drawings and HVAC Details.

B. Air separator and expansion tank to be installed on the suction side of the system pumps. Expansion tank to be tied into system piping in close proximity to air separator and system fill line. Pipe in accordance with the manufacturer's instructions and the HVAC Details.

C. Provide all necessary steel supporting members to support the expansion tank in an approved manner. Support vertical tanks with steel legs or base.

D. Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.

E. Support pump fittings with floor mounted pipe and flange supports.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 15184

PIPING SPECIALTIES FOR HVAC SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This section describes the pipe specialties for HVAC piping systems including, but not limited, to the following:
   1. Drain Valves
   2. Pressure Reducing Fill Valves
   3. Pressure Relief Valves
   4. Strainers
   5. Air Vents
   6. Prefabricated Expansion Compensation Loops
   7. Escutcheons
   8. Water Meters
   9. Nutating Disc Water Meter
   10. Flexible Stainless Steel Hoses
   11. Dielectric Connections

1.02 REFERENCES

A. ASME - Boilers and Pressure Vessel Codes, SEC 8-D-Rules for Construction of Pressure Vessels.

1.03 SUBMITTALS

A. Product Data: Submit product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes and finishes. Include produce description, model and dimensions.

B. Submit manufacturer's instructions for maintenance and repair.

C. Submit a valve and specialty application schedule.

1.04 OPERATION AND MAINTENANCE DATA

A. Maintenance Data: Include installation instructions, assembly views, lubrication instructions and replacement parts list.

1.05 RELATED WORK

A. Section 15180 - Pipe, Valves and Fittings for HVAC Systems

1.06 QUALIFICATIONS

A. Companies specializing in making products specified with at least 5 years of experience and products that have been on the market for at least 3 years.

PART 2 - PRODUCTS

2.01 DRAIN VALVES

A. Provide drain valves, ball type with ¾ inch hose connector, at all low points of water systems, on strainers, and in all locations as shown on the Drawings. Provide minimum 3/4 inch drain size. Provide caps or plugs with chain at all drain and fill valves.

2.02 PRESSURE REDUCING FILL VALVES

A. Pressure reducing fill valve shall have built in strainer, by-pass and all separation valves.

B. Adjustable range of 10 TO 25 PSIG.

C. Install pressure reducing valve with unions on inlet and outlet to facilitate removal.

D. Approved Manufacturer: Bell & Gossett or approved equal.

2.03 PRESSURE RELIEF VALVES

A. Engineered in accordance with Section IV of the ASME boiler and pressure code for heating boilers with capacities certified by the National Board of Boiler and Pressure Vessel Inspectors.

B. Bronze body and EPDM diaphragm

C. Rated for maximum operating temperature of 250 degrees F and maximum working pressure of 125 psig.

D. Pressure setpoint shall be as called for on the HVAC Details and the Equipment Schedules. Relief capacity shall meet or exceed the maximum heat output of the device it serves.

E. Approved Manufacturers: Bell and Gossett, Watts or approved equal.

2.04 STRAINERS

A. General:
   1. Provide strainers ahead of all pumps, automatic control valves, as specified for piping installations, as shown on the Drawings, and as required for proper functioning of equipment.

B. Steam and Water Strainers
   1. Y" type or "Basket" type, as shown on the Drawings.

2. Provide a strainer screen blow down valve the full size of the blow-off tapping for each strainer. Provide ball valve with ½ inch hose end.
3. Stainless steel strainer screens with perforations as follows:

Pipe Size (Inches)	Water Service Perforations (Inches)	Steam Service Perforations (Inches)
Thru 4	1/16 (except at cooling tower pumps shall be 1/8)	1/32
Over 4	1/8	3/64

4. Select the length of the nipple connecting the blow-off valve to the strainer basket flange so that the blow-off valve is clear of the insulation.
5. Select strainers with bodies compatible with connected piping from the following schedule for the service intended.

Size	Manufacturer	Strainer Type	Model No.	Description
2 inches & smaller	Mueller Steam Specialty	Y	11M	Cast iron body, threaded ends, ANSI Class 250
2 inches & smaller	Mueller Steam Specialty	Y	358S	Bronze body, soldered ends, ANSI Class 125, for copper pipe
2 ½ inches & larger	Mueller Steam Specialty	Y	758	Cast iron body, flanged ends, ANSI Class 125
2 inches & smaller	Mueller Steam Specialty	Basket	125	Cast iron body, screwed ends, ANSI Class 125
2 inches & smaller	Mueller Steam Specialty	Basket	125B	Bronze body, screwed ends, ANSI Class 150, for copper pipe
2 ½ inches & larger	Mueller Steam Specialty	Basket	166	Cast iron body, flanged ends, ANSI Class 250

2.05 AIR VENTS

A. Automatic Air Vents:

1. Float actuated high capacity air vent designed to purge free air from the system and provide shutoff at pressures up to 150 psig at a maximum temperature of 250 degrees F. Design to prevent air from entering the system if system pressure drops below atmospheric pressure and to purge free air at pressures up to 150 psig during normal system operation.
2. Cast iron and fitted with components of stainless steel, brass, and EPDM.
3. Provide a shutoff ball valve before the automatic air to isolate the air vent from the system.
4. Approved Manufacturer: ITT Bell & Gossett Model 107A pr approved equal.

B. Manual Air Vents:
1. ½ inch ball valves with ½ inch hose ends.

2.06 PREFABRICATED EXPANSION COMPENSATION LOOPS

A. Provide flexible expansion loops of size and type noted on Drawings.

B. Two flexible sections of hose and braid, two 90 degree elbows, and a 180 degree return assembled in such a way that the piping does not change direction, but maintains its course along a single axis.

C. Factory supplied, center support nut located at the bottom of the 180 degree return, and a drain/air release plug. Design flexible loops so that no thrust loads are imparted to system support anchors or building structure.

D. Install in a neutral, pre-compressed or pre-extended condition as required for the application. For steam service, install loops with flexible legs horizontal to prevent condensate buildup. Install and guide per manufacturer's recommendations.

E. Select materials of construction and end fitting type to be consistent with pipe material and equipment/ pipe connection fittings. Connectors A.G.A. certified natural gas service. Connectors UL classified in accordance with ANSI/NSF 61 standards for potable water service.

F. Approved Manufacturer: The Metraflex Company, Chicago, IL or approved equal.

2.07 ESCUTCHEONS

A. Provide escutcheons with spring-catch fasteners at all locations where insulated or uninsulated piping, installed exposed to view, penetrates wall, partitions, floors, and ceilings.

B. Plain pattern, chrome-plated brass for all piping except galvanized steel.

C. Galvanized around galvanized steel pipe.

D. Deep recess to cover sleeves at floor penetrations.

2.08 WATER METER

A. Comply with the requirements of the applicable American Water Works Association (AWWA) Standards and NSF/ANSI Standards.

B. Velocity-type meter designed to evenly distribute water through an impeller creating an impeller velocity directly proportional to water flow rate.

C. Main case constructed of EnviroBrass II, 87% copper, low lead bronze. Measuring chamber housing and measurement element constructed of a durable synthetic polymer and easily removable from the main case without removal of the meter from the line. Chamber housing constructed in two parts to allow access to the impeller.

D. Direct magnetic drive to provide linkage between measurement element and register.

E. Register permanently sealed with a tempered glass lens, stainless steel base and wrap around gasket to prevent intrusion of dirt or moisture. Include electrical impulse contactor for remote monitoring by the Building Automation System and the chemical treatment system.

F. Include a 360-degree polymer basket strainer.

G. Approved Manufacturer: Multi-Jet Meter by Master Meter or approved equal.

2.09 NUTATING DISC WATER METER

A. Comply with the requirements of the applicable American Water Works Association (AWWA) Standard C700 and NSF/ANSI Standards.

B. Magnetic driven flat nutating type disc meter.

C. Main case constructed of NSF/ANSI 61, Annex G and Annex F certified lead free alloy containing a minimum of 85% copper. Main case markings shall be cast raised and shall indicate size, model, direction of flow and NSF 61 certification.

D. Register shall be of the straight reading sealed magnetic type and shall contain six numerical wheels. Registers shall be roll sealed and dry. Register cups shall be copper and covered with a tempered flat glass lens. Position register lid above register box to prevent intrusion of dirt or moisture. Register box and lids shall be high-strength polymer or approved equal. Stamp size, model and date of manufacture on dial face. The dial shall have a red center sweep hand and shall contain one hundred equally divided graduations at its periphery.

E. The register shall contain a low flow indicator with a 1:1 ratio to disc nutations to provide leak detection.

F. Measuring chamber shall be of a two-piece snap-joint type. Measuring chamber and control block shall be constructed of non-hydrolyzing synthetic polymer. Nutating disc

shall be a single piece fabricated from synthetic polymer and shall contain a Type 316 stainless steel spindle.

G. Include electrical impulse contactor for remote monitoring by the Building Automation System.

H. Include a removable polymer strainer.

I. Approved Manufacturer: Neptune Type T-10 with Trico E output device.

2.10 FLEXIBLE STAINLESS STEEL HOSE

A. Stainless steel braid and carbon steel fittings.

B. End connections: Sizes 2 ½ "and smaller, threaded male nipples. Sizes 3" and larger, flanged.

C. Minimum lengths as tabulated below:

SIZE (INCHES)	MINIMUM SIZE (INCHES)	SIZE (INCHES)	MINIMUM LENGTH (INCHES)
1/2	9	4	15
3/4	10	6	20
1	11	8	22
1 1/4	12	10	26
1 1/2	13	12	28
2	14	14	30
2 1/2	18	16	32
3	14		

D. Approved Manufacturer: Type BSS as manufactured by Mason Industries, Inc. or approved equal.

2.11 DIELECTRIC CONNECTIONS

A. Approved Manufacturer: Watts Regulator Series 3000 Dielectric Unions and Flange Systems

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Install work in accordance with manufacturer's instructions and as shown on the Drawings and HVAC Details.

B. Furnish and connect to all valves, brass tags, polished or lacquered, with stamp lettering or numbers filled in with black paint. Identify each zone.

C. Secure escutcheons to the pipe or insulation and flush with the building surface.

D. Clean the valves and place them in final operating position

3.02 STRAINER INSTALLATION

A. Installed strainers so they are readily accessible

B. Remove start-up strainer screen from suction diffusers and strainers and install permanent screens prior to balancing water systems.

3.03 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible stainless steel hoses at all locations as called for in equipment manufacturer's instructions and/or as shown on the HVAC Details.

B. Install connectors the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.

C. Install expansion joints in piping gaps equal to the length of the expansion joints under pressure.

3.04 RELIEF VALVE INSTALLATION

A. Furnish and connect to all relief valves, etc., brass tags with stamp lettering or numbers filled in with black paint indicating the working pressure or set pressure.

B. If, in the opinion of the Engineer, relief valves, vents and drains have been installed so as to create a hazardous and unsafe condition, make corrections as directed without additional charge.

3.05 AIR VENT INSTALLATION

A. Provide automatic air vents with ¼ inch copper drip lines to the nearest floor drain.

B. Install air vents where shown on the Drawings and at the high points of all systems and at other locations as required to allow complete venting of air from the system.

3.06 DIELECTRIC CONNECTIONS

A. Isolate connections between dissimilar metallic materials. Use dielectric unions or flanges that provide a complete isolation of the two ends, including bolts for flanges, using materials suitable for the design pressure, temperature and fluid contained.

+ + END OF SECTION + +

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SECTION 15185

HYDRONIC HVAC PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Base Mounted End Suction Pumps and associated Variable Frequency Drives.

B. Inline Ciculator Pumps and associated Variable Frequency Drives.

1.02 SUBMITTALS

A. Product Data
   1. Submit manufacturer's pump specifications, installation and start-up instructions, and pump characteristic performance curves with selection points clearly indicated.

B. Shop Drawings
   1. Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances and methods of assembly of components.

C. Wiring Diagrams
   1. Submit manufacturer's electrical requirements for power supply wiring to HVAC pumps. Submit manufacturer's wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Maintenance Data
   1. Submit maintenance data and parts lists for each type of pump, control, and accessory; including troubleshooting maintenance guide. Include this data, product data, shop drawings and wiring diagrams in maintenance manual; in accordance with requirements of Division 01.

E. Warranty
   1. Submit warranty for each pump with complete description of the warranty procedures.

1.03 RELATED SECTIONS

A. Section 15180 - Pipe, Valves, and Fittings for HVAC Systems

B. Section 15183 - Hydronic Specialties for HVAC Systems

C. Section 15184 - Piping Specialties for HVAC Systems

D. Section 15990 - Testing, Adjusting, and Balancing of Air and Hydronic HVAC Systems

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications
   1. Firms regularly engaged in manufacturing of centrifugal pumps with characteristics, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Codes and Standards
   1. HI Compliance: Design, manufacture and install HVAC pumps in accordance with HI "Hydraulic Institute Standards".
   2. UL Compliance: Design, manufacture and install HVAC pumps in accordance with UL 778 "Motor Operated Water Pumps".
   3. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA Standards.

C. Certification, Pump Performance
   1. Supply name plate data on pumps: Each pump shall be provided with the following data : GPM, FT of Head, and Model number.
   2. Supply name plate data on motors and drives: Each motor and drive shall be provided with the following data: HP, Voltage, and Model number.

1.05 WARRANTY

A. Contractor shall ensure that all units are registered with the manufacturer to ensure all warranties are in place after unit installation.

B. Pumps and VFD's shall be warranted for a period of one (1) year from date of installation.

1.06 DELIVERY, STORAGE AND HANDLING

A. Handle HVAC pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged HVAC pumps or components; replace with new.

B. Store HVAC pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

C. Comply with Manufacturer's rigging and installation instructions for unloading HVAC pumps and moving them to final location.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers include:

1. TACO
2. Bell & Gossett
3. Armstrong

2.02 BASE MOUNTED FLEX COUPLED END-SUCTION PUMPS (P-1 THRU P-4)

A. General
   1. Furnish and install pumps with performance characteristics as shown on plans. Pumps shall be base mounted, single stage, end suction design with a foot mounted volute to allow removal and service of the entire rotating assembly without disturbing the pump piping, electrical motor connections or pump to motor alignment.
   2. The pump(s) selected shall conform to ANSI/HI 9.6.3.1-2012 standards for Preferred Operating Region (POR) unless otherwise approved by the engineer.
   3. Each pump shall be factory hydrostatically tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade paint prior to shipment.
   4. Pumps shall be suitable for use with Variable Frequency Drives and shall include shaft grounding.

B. Pump
   1. Pump volute shall be Class 30 cast iron with integrally-cast pedestal support feet.
   2. The impeller shall be a cast stainless steel enclosed type, balanced to ANSI/HI 9.6.4-2016 balance grade G6.3 and secured to the shaft by a locking cap screw or nut.
   3. Pump shall be rated for minimum of 175 psi (12 bar) working pressure. Volute shall have gauge tappings at the suction and discharge nozzles and vent and drain tappings at the top and bottom.
   4. The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225°F (107°C).
   5. A replaceable stainless steel shaft sleeve shall completely cover the wetted area under the seal.
   6. The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 9.6.4-2016 for recommend acceptable unfiltered field vibration limits (as measured per ANSI/HI 9.6.4-2016 Figure 9.6.4.2.3.1) for pumps with rolling contact bearings.

C. Baseplate
   1. Shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members.
   2. Grouting area shall be fully open. The combined pump and motor baseplate shall be sufficiently stiff as to limit the susceptibility of vibration.
   3. The minimum baseplate stiffness shall conform to ANSI/HI 1.3.8.2.1-2019 for grouted Horizontal Baseplate Design standards.

D. Coupling

1. A flexible type, center drop-out design coupling, capable of absorbing torsional vibration, shall be employed between the pump and motor.
2. Pumps for variable speed application shall be provided with a suitable coupling sleeve. The coupling shall be shielded by a dual rated ANSI B15.1 & OSHA 1910.219 compliant coupling guard and contain viewing windows for inspection of the coupling.

E. Motor
1. Motor shall meet NEMA and EISA 2007 (where applicable) specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by the contractor per factory recommendations after installation.

F. The pump(s) shall be manufactured, assembled and tested in an ISO 9001 approved facility.

G. Variable Frequency Drives
1. Protective Features
a. The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor de-rating.
b. When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor.
c. The VFD shall maintain a fundamental (displacement) power factor near unity regardless of speed or load.
d. The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
e. The VFD's full load output current rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.
f. A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
g. Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.
h. An automatic motor adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not

be necessary to run the motor or de-couple the motor from the load to perform the test.

i. Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanc or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.
j. VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.
k. A minimum of Class 20 I2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.
l. Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.
m. Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.
n. Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.
o. Protect from over voltage. The VFD shall continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.
p. The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.
q. VFD shall include a "signal loss detection" algorithm with adjustable time delay to sense the loss of an analog input signal. It shall also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection shall be programmable.
r. VFD shall function normally when the keypad is removed while the VFD is running. No warnings or alarms shall be issued as a result of removing the keypad.
s. VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.
t. Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.

u. VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.
v. If the temperature of the VFD's heat sink rises to 80ºC, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.
w. In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.
x. The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.
y. The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.
z. When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

2. Interface Features
   a. Hand, Off and Auto keys shall be provided to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.
   b. There shall be an "Info" key on the keypad. The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.
   c. The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode.
   d. Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.
   e. All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.
   f. To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.
   g. Display shall be programmable to communicate in multiple languages including English, Spanish
   h. and French.
   i. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

j. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.
k. The VFD's PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.
l. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
m. Five simultaneous meter displays shall be available. They shall include at a minimum, frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, among others.
n. Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.
o. A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.
p. VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F).
q. VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

3. Startup Genie
   a. A Quick Set-up Genie shall be included that immediately starts upon power up.
   b. The following applications shall be programmable without leaving the genie.
      1) Single pump
      2) 2 pump
      3) Duplex Mode (synchronous)
      4) Duty/Standby
      5) Master/Fixed lag
      6) Speed control

c. The Genie shall only ask users to enter parameters that are required for the selected application to avoid confusion about what is required
d. The Genie shall include an "Autoset" feature to quickly program the drive to common default values specific to the selected application type
e. The Quick Set-up Genie shall automatically include programming for the following system safety Features:
    1) Flow Check
    2) Sleep Speed
    3) No Flow Power Detection
    4) Flow compensation
    5) No water/Loss of prime
    6) Sensor Fault
    7) Under Pressure
f. Ramp times shall be selectable via the Genie and allow for Slow, Medium or Fast
g. The Genie Shall allow for multiple feedback source programming
h. The Genie Shall allow for differential pressure computation.
i. The Genie Shall allow analog signals to be quickly scaled
j. The Genie Shall be easily accessed from the main menu

4. Standard Inputs and Outputs
    a. Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
    b. Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.
    c. Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.
        1) Each relay shall have an adjustable on delay /off delay time.
    d. Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.
        1) Each shall be independently selectable to be used with either an analog voltage or current signal.
        2) The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 Vdc and 0 to 20 mA.
        3) A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
        4) The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting
    e. One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.
    f. It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.

g. It shall be possible to command all digital and analog output through the serial communication bus.
h. Optional Control and Monitoring Inputs and Outputs
    1) It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.
    2) These modules shall use rigid connectors to plug into the VFD's control card.
    3) The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.
    4) Modules may include such items as:
        (a) Additional digital outputs, including relay outputs
        (b) Additional digital inputs
        (c) Additional analog outputs
        (d) Additional analog inputs, including Ni or Pt temperature sensor inputs
    5) It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.
    6) A real-time clock shall be an integral part of the VFD.
        (a) It shall be possible to use this to display the current date and time on the VFD's display.
        (b) Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.
        (c) All VFD faults shall be time stamped to aid troubleshooting.
        (d) It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.
        (e) The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.
    7) The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.
    8) The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:
        (a) Comparators for comparing VFD analog values to programmed trigger values
        (b) Logic operators to combine up to three logic expressions using Boolean algebra
        (c) Delay timers
        (d) A 20-step programmable structure
    9) The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a

controlled speed and control the operation of 3 additional constant speed motor starters.

5. Serial Communications
   a. The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
      1) Johnson Controls Metasys N2
      2) Modbus RTU
      3) BACnet
   b. VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.
   c. The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.
   d. Adjustments
      1) The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.
      2) Four independent setups shall be provided.
      3) Four preset speeds per setup shall be provided for a total of 16.
      4) Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.
      5) Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.
      6) If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.
      7) The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
      8) An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

9) Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

6. Service Conditions
   a. Ambient temperature, continuous, full speed, full load operation:
      1) -10 to 45°C (14 to 113°F) through 125 HP @ 460 and 600 volt, through 60 HP @ 208 volt
      2) -10 to 40°C (14 to 104°F) 150 HP and larger
   b. 0 to 95% relative humidity, non-condensing.
   c. Elevation to 3,300 feet without derating.
   d. AC line voltage variation, -10 to +10% of nominal with full output.
   e. No side clearance shall be required for cooling.
   f. All power and control wiring shall be done from the bottom.
   g. All VFDs shall be plenum rated.
7. Quality Assurance
   a. To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.
   b. All optional features shall be functionally tested at the factory for proper operation.

2.03 INLINE CIRCULATOR PUMPS (P-5 THRU P-14)

A. Pumps shall be rated for max operating pressure of 150 PSIG and max operating temperature of 225°F.

B. Pump casing shall be coated cast iron for HVAC duty, or stainless steel for domestic hot water duty.

C. Pump impeller shall be 30% glass filled Noryl.

D. Shaft shall be stainless steel.

E. Pump shall utilize sealed ball bearings.

F. Mechanical seal shall be Carbon-SiCarbide-EPT.

G. Motors shall be EC type for pumps provided with integral speed controllers, or PSC type for constant speed pumps, as required by the equipment schedules.

H. Motor shall be rated for continuous duty and shall have integral protection.

I. Motor shall be speed controllable and shall include integral controller where called for on the schedules.

J. Controls options and requirements shall be as called for on the schedules and sequence of operations.

K. Electrical requirements shall be as called for on the schedules.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which HVAC pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to the Engineer.

3.02 INSTALLATION

A. General
   1. Install pumps in accordance with the HVAC Details and manufacturer's instructions. Bring any discrepancies between the Details and manufacturer's instructions to the Engineer's attention for review.
   2. Pumps shall be installed level.
   3. Pipe connections to pumps shall be made in such a manner so as not to exert any stress on pump housings. If necessary to meet this requirement, provide additional pipe supports and flex connectors.
   4. Pumps shall NOT be run dry to check rotation.
   5. Change start-up strainers to permanent strainer upon completion of the work prior to system balancing.

B. Electrical Wiring
   1. Install electrical devices furnished by manufacturer but not specified to be factory-mounted.
   2. Provide the control wiring between field-installed controls, integral controls, and pump control panels.
   3. Ensure wiring is in accordance with Division 16.

C. Do not proceed with equipment start-up until installation is acceptable to equipment manufacturer's representative.

3.03 TEST AND BALANCE

A. Refer to Section 15990 - Testing, Adjusting, and Balancing of Air and Hydronic HVAC Systems

3.04 ADJUSTING AND CLEANING

A. Check alignment, and where necessary, realign shafts of motors and pumps within tolerances recommended by the manufacturer and in presence of manufacturer's service representative.

B. Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions and in presence of manufacturer's service representative.

C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

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SECTION 15186

REFRIGERANT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Requirements of the following Division 23 Sections apply to this section:
   1. Section 15000 - General Mechanical Requirements for HVAC
   2. Section 15060 - Hangers And Supports for HVAC Ductwork, Piping, and Equipment
   3. Section 15075 - Mechanical System Identification for HVAC Systems
   4. Section 15082 - Pipe Insulation for HVAC Systems

1.02 SUMMARY

A. This Section includes refrigerant piping used for air conditioning applications. This Section includes:
   1. Piping, tubing, fittings, and specialties.
   2. Special duty valves.
   3. Refrigerants.

B. Products installed but not furnished under this Section include pre-charged tubing, refrigerant specialties, and refrigerant accessories furnished as an integral part of or separately with packaged air conditioning equipment.

1.03 SUBMITTALS

A. Product data for the following products:
   1. Each type of valve specified.
   2. Each type of refrigerant piping specialty specified.

B. Shop Drawings showing layout of refrigerant piping, specialties, and fittings including, but not necessarily limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and proximity to equipment.

C. Brazer's Certificates signed by Contractor certifying that brazers comply with requirements specified under "Quality Assurance" below.

D. Maintenance data for refrigerant valves and piping specialties, for inclusion in Operating and Maintenance Manual specified in Division 01 and Division 15.

1.04 QUALITY ASSURANCE

A. Qualify brazing processes and brazing operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications".

B. Regulatory Requirements: Comply with provisions of the following codes:
   1. ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping.
   2. ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration.

C. Mechanical Code of New York State

1.05 SEQUENCING AND SCHEDULING

A. Coordinate the installation of roof piping supports, and roof penetrations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include, but are not limited to, the following:

B. Refrigerant Valves and Specialties:
   1. Alco Controls Div, Emerson Electric
   2. Danfoss Electronics, Inc
   3. EATON Corporation, Control Div
   4. Henry Valve Company
   5. Parker-Hannifin Corporation, Refrigeration and Air Conditioning Division
   6. Sporlan Valve Company

2.02 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3, Article "PIPE APPLICATIONS" for identification of systems where the below specified pipe and fitting materials are used.

B. Copper Tubing: ASTM B 280, Type ACR, hard-drawn straight lengths, and soft-annealed coils, seamless copper tubing. Tubing shall be factory cleaned, ready for installation, and have ends capped to protect cleanliness of pipe interiors prior to shipping.
   1. Soft-annealed copper is permitted only on Group A1 refrigerants (including R-410A and R-513A) and not permitted for use with Group A2L refrigerants (including R-454B and R-32).

C. Copper Tubing: ASTM B 88, Type L, hard-drawn straight lengths, and soft-annealed coils, seamless copper tubing.
   1. Soft-annealed copper is permitted only on Group A1 refrigerants (including R-410A and R-513A) and not permitted for use with Group A2L refrigerants (including R-454B and R-32).

2.03 FITTINGS

A. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern for hard drawn and soft copper.

2.04 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (Silver)

2.05 VALVES

A. General: Complete valve assembly shall be UL-listed and designed to conform to ARI 760.

B. Globe: 450 psig maximum operating pressure, 275 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass wing cap and bolted bonnet; replaceable resilient seat disc; plated steel stem. Valve shall be capable of being repacked under pressure. Valve shall be straight through or angle pattern, with solder-end connections.

C. Check Valves - Smaller Than 7/8 inch: 500 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast brass body, with removable piston, Teflon seat, and stainless steel spring; straight through globe design. Valve shall be straight through pattern, with solder-end connections.

D. Check Valves - 7/8 inch and Larger: 450 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass bolted bonnet; floating piston with mechanically retained Teflon seat disc. Valve shall be straight through or angle pattern, with solder-end connections.

E. Solenoid Valves: 250 deg. F temperature rating, 400 psig working pressure; forged brass, with Teflon valve seat, two-way straight through pattern, and solder end connections. Provide manual operator to open valve. Furnish complete with NEMA 1 solenoid enclosure with 1/2 inch conduit adapter, and 24 volt, 60 Hz. normally closed holding coil.

F. Hot Gas Bypass Valve: adjustable type, sized to provide capacity reduction beyond the last step of compressor unloading; and wrought copper fittings for solder end connections.

2.06 REFRIGERANT PIPING SPECIALTIES

A. General: Complete refrigerant piping specialty assembly shall be UL-listed and designed to conform to ARI 760.

B. Strainers: 500 psig maximum working pressure; forged brass body with monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder end connections.

C. Moisture/liquid Indicators: 500 psig maximum operation pressure, 200 deg. F maximum operating temperature; forged brass body, with replaceable polished optical viewing window, and solder end connections.

D. Filter-driers: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-drier core kit, including gaskets. Standard capacity desiccant sieves to provide micronic filtration.

E. Flanged Unions: 400 psig maximum working pressure, 330 deg. F maximum operating temperature; two brass tailpiece adapters for solder end connections to copper tubing; flanges for 7/8 inch through 1-5/8 inch unions shall be forged steel, and for 2-1/8 inch through 3-1/8 inch shall be ductile iron; four plated steel bolts, with silicon bronze nuts and fiber gasket. Flanges and bolts shall have factory-applied rust-resistant coating.

F. Flexible Connectors: 500 psig maximum operating pressure; seamless tin bronze or stainless steel core, high tensile bronze braid covering, solder connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inch in length.

2.07 REFRIGERANT

A. Refrigerant as called for on the Equipment Schedules and the Equipment Specification Sections, in accordance with ASHRAE Standard 34.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine rough-in for refrigerant piping systems to verify actual locations of piping connections prior to installation.

3.02 PIPE APPLICATIONS

A. Use Type L, or Type ACR drawn copper tubing with wrought copper fittings and brazed joints above ground, within building. Use Type K, annealed temper copper tubing for 2 inch and smaller without joints, below ground and within slabs. Mechanical fittings (crimp or flair) are not permitted.

B. Install annealed temper tubing in pipe duct. Vent pipe duct to the outside.

C. If other than Type ACR tubing is used, clean and protect inside of tubing as specified in Article "CLEANING" below.

3.03 PIPING INSTALLATIONS

A. General: Install refrigerant piping in accordance with ASHRAE Standard 15 - "The Safety Code for Mechanical Refrigeration."

B. Install piping in as short and direct arrangement as possible to minimize pressure drop.

C. Install piping for minimum number of joints using as few elbows and other fitting as possible.

D. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.

E. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.

F. Insulate suction lines. Liquid line are not required to be insulated, except where they are installed adjacent and clamped to suction lines, where both liquid and suction lines shall be insulated as a unit.

G. Do not install insulation until system testing has been completed and all leaks have been eliminated.

H. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.

I. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

J. Slope refrigerant piping as follows:
   1. Install horizontal hot gas discharge piping with 1/2" per 10 feet downward slope away from the compressor.
   2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
   3. Liquid lines may be installed level.

K. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.

L. Use fittings for all changes in direction and all branch connections.

M. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

N. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

O. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

P. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

Q. Locate groups of pipe parallel to each other, spaced to permit applying insulation and servicing of valves.

R. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inch and larger shall be sheet metal.

S. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 07 for special sealers and materials.

T. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

U. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.

V. Install moisture/liquid indicators in liquid lines between filter/driers and thermostatic expansion valves and in liquid line to receiver.

W. Install moisture/liquid indicators in lines larger than 2-1/8 inch OD, using a bypass line.

X. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.

Y. Install flexible connectors at the inlet and discharge connection of compressors.

3.04 HANGERS AND SUPPORTS

A. General: Hanger, supports, and anchors are specified in Division 15 Section "PIPE HANGERS AND SUPPORTS." Conform to the table below for maximum spacing of supports:

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.

C. Support horizontal copper tubing in accordance with MSS SP-69 Tables 3 and 4, excerpts of which follow below:

NOMINAL PIPE SIZE (Inches)	ROD DIAMETER (Inches)	MAXIMUM SPACING (Feet)
1/2 to 3/4	3/8	5
1	3/8	6
1-1/4	3/8	6
1-1/2	3/8	8
2	3/8	8

D. Support vertical runs at each floor.

3.05 PIPE JOINT CONSTRUCTION

A. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

B. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

C. CAUTION: When solenoid valves are being installed, remove the coil to prevent damage. When sight glasses are being installed, remove the glass. Remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties before brazing. Do no apply heat near the bulb of the expansion valve.

D. Fill the pipe and fittings during brazing, with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.

E. Heat joints using oxy-acetylene torch. Heat to proper and uniform brazing temperature.

3.06 VALVE INSTALLATIONS

A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.

B. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere as indicated.

C. Install a full sized, 3-valve bypass around each drier.

D. Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at the top.

E. Electrical wiring for solenoid valves is specified in Division 16. Coordinate electrical requirements and connections.

F. Thermostatic expansion valves may be mounted in any position, as close as possible to the evaporator.

G. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.

H. Install the valve in such a location so that the diaphragm case is warmer than the bulb.

I. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps. Do not mount bulb in a trap or at the bottom of the line.

J. Where external equalizer lines are required make the connection where it will clearly reflect the pressure existing in the suction line at the bulb location.

K. Install pressure regulating and relieving valves as required by ASHRAE Standard 15.

3.07 EQUIPMENT CONNECTIONS

A. The Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow servicing and maintenance.

3.08 FIELD QUALITY CONTROL

A. Inspect, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI.

B. Repair leaking joints using new materials, and retest for leaks.

3.09 CLEANING

A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:
   1. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.
   2. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
   3. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
   4. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

3.10 ADJUSTING AND CLEANING

A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Clean and inspect refrigerant piping systems in accordance with requirements of Division-15 General Mechanical Requirements

C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.11 COMMISSIONING

A. Charge system using the following procedure:
   1. Install core in filter dryer after leak test but before evacuation.
   2. Evacuate refrigerant system with vacuum pump; until temperature of 35 deg F is indicated on vacuum dehydration indicator.
   3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
   4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
   5. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.
   6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.
   7. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

B. Review data in Operating and Maintenance Manuals. Refer to Division 01 section "Project Closeout."

C. Schedule training with Owner with at least 7 days advance notice.

+ + END OF SECTION + +

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SECTION 15400

VALVES FOR PLUMBING SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Gate valves

B. Globe and angle valves

C. Check valves

D. Ball valves

1.02 ABBREVIATIONS

A. IBBM: Iron body, bronze mounted.

B. OS&Y: Outside screw and yoke.

C. WOG: Water, oil, gas.

D. WSP: Working steam pressure.

1.03 SUBMITTALS

A. Product Data: Manufacturer's catalog sheets and specifications for each valve type.

B. Valve Schedule: List type of valve, manufacturer's model number, and size for each service application.

1.04 MAINTENANCE

A. Special Tools:
   1. One wrench for each type and size.

PART 2 PRODUCTS

2.01 VALVES - GENERAL

A. Valve Standardization: Valves from one or more manufacturers may be used, however valves supplied for each specific valve type shall be the product of one manufacturer.

B. Valves shall be first quality, free from all imperfections and defects, with body markings indicating manufacturer and rating.

C. Valve parts of same manufacturer, size and type shall be interchangeable.

D. Manually operated gate, globe and angle valves shall be of rising stem type, unless otherwise specified.

E. Valves which use packing, shall be capable of being packed when wide open and under full working pressure.

F. Size valves the same size as the piping in which they are installed, unless specified otherwise.

2.02 GATE VALVES

A. Type A: 125 psig WSP, 200 psig WOG, bronze body, union bonnet, solid wedge disc, and threaded ends. Acceptable Valves: Crane 428UB, Hammond IB617, Jenkins 47CU, Milwaukee 1152, Nibco T13, and Stockham B105.

B. Type C: 125 psig WSP, 200 psig WOG up to 12 inch size, and 150 psig WOG for 14 inch and 16 inch sizes; IBBM OS&Y, bolted bonnet, solid wedge disc, and threaded or flanged ends depending on size. Acceptable Valves: Crane 464-1/2, 465-1/2, Hammond IR1140, Milwaukee F2885, Nibco T6170 & F6170, and Stockham G620 & G623.

C. Type D: 125 psig WSP, 200 psig WOG, bronze body, threaded bonnet, solid wedge disc, and solder ends. Acceptable Valves: Crane 1330, Hammond IB635, Jenkings 991AJ, Milwaukee 149, Nibco S111, and Stockham B108.

2.03 GLOBE AND ANGLE VALVES

A. Type J: 125 WSP, 200 psig WOG, bronze body, threaded bonnet, and threaded ends. Acceptable Valves: Crane 1, Hammond IB440 & IB463, Jenkins 101J, Milwaukee 502, Nibco T211 & T311, and Stockham B16.

B. Type K: 125 psig WSP, 200 psig WOG, IBBM OS&Y, bolted bonnet, and threaded or flanged ends depending on size. Acceptable Valves: Crane 351, 353, Hammond IR116, Jenkins 613C & 615C, Milwaukee F2981, Nibco F718B & F818B, and Stockham G512 & G515.

C. Type O: 125 psig WSP, 200 psig WOG, bronze body, threaded bonnet, and solder ends. Acceptable Valves: Crane 1310, Hammond IB423, Jenkins 1200C, Milwaukee 1502, Nibco S21, and Stockham B17.

2.04 CHECK VALVES

A. Type S: 125 psig WSP, 200 psig WOG, bronze body, brass or bronze trim, horizontal swing, renewable and regrindable disc, and threaded ends. Face discs for cold water service with teflon. Acceptable Valves: Crane 37, Hammond IB940, Jenkins 4092, Milwaukee 509, Nibco T413Y, and Stockham B319Y.

B. Type U: 125 psig WSP, 200 psig WOG, bronze body, brass or bronze trim, horizontal swing, renewable and regrindable disc, and solder ends. Face discs for cold water

service with teflon. Acceptable Valves: Crane 1340, Hammond IB912, Jenkins 4093, Milwaukee 1509, Nibco S413Y, and Stockham 309Y.

C. Type V: 125 psig WSP, 200 psig WOG, IBBM, horizontal swing, bolted bonnet, regrindable and renewable seat ring and disc, and threaded or flanged ends depending on size. Discs on valves 4 inch size and larger may be cast iron with bronze face. Acceptable Valves: Crane 372, & 373, Hammond IR1124, Jenkins 623CJ & 624CJ, Milwaukee F2974, Nibco F918, and Stockham G927 & G931.

D. Type W:
   1. Globe Style Silent Check Valve: IBBM or semi-steel with bronze mounting, renewable seat and disc, 18-8 stainless steel spring, and flanged ends.
      a. Acceptable Valves (125 psig flange pressure rating): Apco Series 600, Combination Pump & Valve 20D, Hammond IR9354, Milwaukee 1800, Nibco F910, and Williams Hager 636.
      b. Acceptable Valves (250 psig flange pressure rating): Apco Series 600, Combination Pump & Valve 21D, Milwaukee 1800, Nibco F960, and Williams Hager 636.
   2. Wafer Style Silent Check Valve: IBBM or semi-steel with bronze mounting, renewable seat and disc, 18-8 stainless steel spring, and flanged ends.
      a. Acceptable Valves (125 psig flange pressure rating): Apco Series 300, Combination Pump and Valve 10D, Hammond IR9253, Milwaukee 1400, Nibco W910, and Williams Hager 329 & 375.
      b. Acceptable Valves (250 psig flange pressure rating): Apco Series 300, Combination Pump and Valve 11D, Milwaukee 1400, Nibco W960, and Williams Hager 329 & 375.

2.03 BALL VALVES

A. Type BV: 150 psig WSP, 600 psig WOG, 2 piece bronze body, solid blow-out proof stem, teflon seats, chrome plated brass ball, teflon seals, corrosion resistant steel lever handles with vinyl grips, balancing stop, and threaded or solder ends. Acceptable Manufacturers: Conbraco, Hammond, Milwaukee, Nibco, and Watts.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install valves at locations noted on the drawings or specified.

3.02 VALVE APPLICATION SCHEDULE

A. Schedule of valve applications for the different services is as follows:
   1. Cold Water In Buildings and Tunnels (CW) 125 psig and Less:
      a. 3 inch and Less: A or D gates or BV balls, O globes or angles, and S or U checks; or C gates, K globes or angles, and V checks, with solder joint companion flanges.

2. Domestic Hot Water and Domestic Hot Water Circulating (DHW & DHWC) 125 psig and Less:
   a. 3 inch and Less: A or D gates or BV balls, J or O globes or angles, and S or U checks.

++END OF SECTION++

SECTION 15401

MIXING VALVES FOR PLUMBING SYSTEMS

PART 1 GENERAL

1.01 SUBMITTALS

A. Product Data: Manufacturer's catalog sheets, specifications, and installation instructions for each type of mixing valve.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Unless otherwise shown or specified, comply with the applicable requirements of FS WW-P-541.
   2. Local and State Building Codes and Ordinances.

B. Emergency Fixture Requirements: Comply with all applicable requirements of ASSE 1071, ANSI Z358.1, and applicable sections of CSA B125.3.

PART 2 PRODUCTS

2.01 VALVES - GENERAL

A. Valve Body: Cast brass.

B. Internal Components:
   1. Metals: Brass, or stainless steel.
   2. Non-Metals: Materials not adversely affected by contact with water, temperature changes, and normal wear.

C. Finishes: Furnish polished, chrome plated brass, or No. 4 brush finished stainless steel on exposed to view surfaces installed in finished spaces.

D. Single Handle Mixing Valves:
   1. Operation: Valve shuts off in full cold position, and must pass through cold range before delivering warm, and/or hot water.
   2. Temperature Limit Stop: Factory set for 105 degrees F maximum delivery temperature.
   3. Automatic Shut-Down: If one supply should fail, the other will automatically and instantly shut down.

2.02 VALVE TYPES

A. Type A: Thermostatically operated by means of bi-metallic strip, or expansion bellows.

1. Accessories: Combination stop, check and removable strainer.
2. Temperature Range: Cold through 115 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions.

3.02 FIELD QUALITY CONTROL

A. Capacity Check: Operate valve through entire range, and verify rated capacity. Correct discrepancies.

B. Temperature Check: Set valve at full hot position and check delivered water temperature for specified factory setting. Adjust temperature limit stop as required.

++ END OF SECTION ++

SECTION 15402

BACKFLOW PREVENTERS FOR PLUMBING SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Reduced pressure zone principle device

B. Double check valve device

1.02 RELATED SECTIONS

A. Drainage Accessories for Plumbing Systems: Section 15412

1.03 SUBMITTALS

A. Product Data:
   1. Manufacturer's catalog sheets, specifications, and installation instructions for each type backflow preventer and test kit.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with the State Department of Health Sanitary Code for Cross Connection Control, and the other standards listed in Part 2 of this section.
   2. Where conflicts occur between the referenced standards, the most stringent requirements shall apply.
   3. Local and State Building Codes and Ordinances.

1.05 MAINTENANCE

A. Special Tools (as furnished or recommended by the backflow preventer manufacturer). Deliver to the Building Owner:
   1. Test Kit A: Portable, packaged in a substantially built, compartmented carrying case, containing hose, gauge, and fittings required for testing backflow preventer for proper operation, and printed procedure for conducting test.
   2. Test Kit B: Sight tube, of required length, for testing backflow preventer for proper operation, and printed procedure for conducting test.

PART 2 PRODUCTS

2.01 BACKFLOW PREVENTERS

A. Type A: Reduced Pressure Zone Backflow Prevention Device, with atmospheric vent, conforming to ASSE Standard 1013, AWWA C-511, and USC specifications manual for Cross Connection Control.
   1. Performance: 150 psig, and 130 degrees F maximum working conditions.
   2. Assembly: Strainer and gate valve on inlet side, gate valve on outlet side, and four test cocks, all as furnished or recommended by the backflow preventer manufacturer.
   3. Acceptable Manufacturer's: Watts, Zurn Wilkins, Febco

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions.

B. Atmospheric Vent: Pipe vent to spill over closest point of drainage, as directed, maintaining a minimum 12 inch air gap above the drain.
   1. Install air gap fitting when shown, or if atmospheric vent must be connected to drainage line. See Section 15412.

3.02 FIELD QUALITY CONTROL

A. Operation Test: Test kit as specified under Part 1 of this section may be used. Conduct test in the presence of the Owner's Representative.
   1. Type A Backflow Preventer: Test the device with the test kit in accordance with the manufacturer's test procedures.

B. Re-testing: Repair or replace any device failing the operation test, and repeat the test.

++ END OF SECTION ++

SECTION 15403

VACUUM BREAKERS FOR PLUMBING SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Vacuum breakers

B. Fasteners

1.02 RELATED SECTIONS

A. Drainage Accessories for Plumbing Systems: Section 15412.

1.03 SUBMITTALS

A. Product Data:
   1. Manufacturer's catalog cuts, specifications and installation instructions for each type Vacuum Breaker.
   2. Manufacturer's printed test procedure for testing operation of pressure type vacuum breaker.

1.04 MAINTENANCE

A. Special Tools: One for each type and size vandal resistant fastener.

PART 2 PRODUCTS

2.01 VACUUM BREAKERS

A. Type B: Atmospheric vacuum breaker conforming to ASSE 1001 - Pipe Applied Atmospheric Type Vacuum Breakers.
   1. Non-pressure type with polished chrome plated brass body, disc float, silicone disc, bronze internal trim and maximum working conditions of 125 psi and 210 degrees F.
      a. Operation: Internal disc float drops, closes orifice, and opens atmospheric vent upon back siphonage.
      b. Connections: Female threaded inlet and outlet.

B. Type D: Pressure type vacuum breaker conforming to ASSE 1020 - Vacuum Breakers, Anti-Siphon, Pressure Type.
   1. Chrome plated bronze body with spring loaded disc float and check valve; bronze internal trim, silicone rubber discs, stainless steel hood, gate valve on inlet and outlet, 2 test cocks, and maximum working conditions of 150 psi and 210 degrees F.

a. Operation: Internal disc float opens atmospheric vent and check valve closes inlet when line pressure drops to one psi or below.
b. Connections: Female threaded inlet and outlet.

2.02 FASTENERS

A. Vandal Resistant: Allen or spanner head bolts. Phillips head and slotted head fasteners are not acceptable.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this Section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.

3.02 FIELD QUALITY CONTROL

A. Operation Test:
1. Check vacuum breaker for leaking under normal operating conditions.
2. Apply negative pressure to the vacuum breaker inlet, and observe that the device opens to the atmosphere.
3. Type D Vacuum Breaker: Test the device in accordance with the manufacturer's printed test procedure.
4. Repair or replace any device failing the operation test, and retest.

++ END OF SECTION ++

SECTION 15404

FLOOR AND AREA DRAINS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Floor drain for installation in concrete flooring

B. Area drain

C. Fasteners

1.02 REFERENCES

A. Unless otherwise specified, the Work of this section shall meet the applicable requirements of FS WW-P-541 - Plumbing Fixtures, and ASME A112.21.1M - Floor Drains.

1.03 SUBMITTALS

A. Product Data: Catalog sheets, specifications and installation instructions for each type drain specified.

1.04 MAINTENANCE

A. Special Tools: Deliver to the Building Owner.

B. Tools for Vandal Resistant Fasteners: One for each type and size.

PART 2 PRODUCTS

2.01 FLOOR DRAIN – CONCRETE FLOORING

A. Drain Body: Coated cast iron, two-piece body with reversible flashing clamp, minimum 9 inch dia. drainage flange, corrosion resistant bolts, weep holes, bottom outlet, and connection to match piping option selected.

B. Strainer Head: Round, minimum 7 inch dia., nickel bronze with threaded shank for height adjustment.

C. Strainer Grate: Polished nickel bronze, heel proof; secured with stainless steel vandal resistant fasteners.

D. Acceptable Drain Series: Josam 30000A, Smith 2010A, Wade W1100, and Zurn Z415.

2.02 AREA DRAIN

A. Drain Body: Dura-coated cast iron, two-piece body with reversible flashing clamp, minimum 15 inch dia. drainage flange with 12" grate, corrosion resistant bolts, weep holes, bottom outlet, and connection to match piping option selected.

B. Strainer Head: Square, minimum 12 inch dia., dura-coated, with threaded shank for height adjustment.

C. Strainer Grate: At least medium duty, cast iron, loose slotted, duresist grate, heel proof; secured with stainless steel vandal resistant fasteners.

D. Acceptable Drain Series: Watts FD-330, and Zurn Z610 & 154.

2.03 FASTENERS

A. Corrosion Resistant Fasteners: Brass, bronze, or Type 302 or 304 or stainless steel bolts.

B. Vandal Resistant Fasteners: Torx head with center pin.

2.04 FREE AREA OF GRATE

A. Minimum strainer grate free area listed below for each connecting pipe size:

CONNECTING PIPE SIZE (Inches Nominal)	**INTERIOR DRAINS FREE AREA (Square Inches)**	**EXTERIOR DRAINS FREE AREA (Square Inches)**
1-1/2	3.06	4.08
2	4.71	6.28
3	10.59	14.12
4	18.90	25.20
5	29.40	39.20
6	42.45	56.60
8	75.38	100.50

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.

B. Protect weep holes from plugging during installation. Rod out weep holes after installation to remove obstructions.

C. Set drainage flange flush with top of structural floor slab, or at elevation otherwise indicated.

D. After membrane waterproofing installed and cured, secure clamping ring.

E. Adjust strainer head to height indicated. If height not indicated, set at 1/2 inch below finished floor elevation.

F. Secure external components in place with vandal resistant fasteners or devices which cannot be removed without special tools.

++ END OF SECTION ++

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SECTION 15405

CONCRETE PADS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General concrete pad requirements

1.02 RELATED SECTIONS

A. Cast-In-Place Concrete: Section 03300.

1.03 REFERENCES

A. Except as shown or specified otherwise, the Work of this Section shall conform to the requirements of Specifications for Structural Concrete for Buildings ACI 301 of the American Concrete Institute.

1.04 SUBMITTALS

A. Shop Drawings: Placing drawings for bar reinforcement.

B. Quality Control Submittals:
   1. Certificates: Bar reinforcement manufacturer's certification that bar material conforms with ASTM A 615 and specified grade.

1.05 STORAGE

A. Store materials as required to insure the preservation of their quality and fitness for the Work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete: Section 03300, Class A.

B. Anchor Bolts: Standard bolts, ASTM A 307, with lock washers and nuts.

C. Steel Plates: ASTM A 36.

D. Sleeves: Steel Pipe, Schedule 40, black, ASTM A 53.

E. Steel Shims and Fillers: ASTM A 569.

F. Reinforcement: Furnish the following unless otherwise indicated on the Drawings:
   1. Fabric Reinforcement: ASTM A 1064 welded wire fabric, 6 x 6 - W2.9 x W2.9 fabricated into flat sheets unless otherwise indicated.
   2. Bar Reinforcement: ASTM A 615, Grade 60, deformed.
   3. Metal Bar Supports: Galvanized or AISI Type 430 stainless steel, and without plastic tips.
   4. Tie Wire: Black annealed wire, 16 gage minimum.

G. Fly Ash: ASTM C 618, including Table 1A (except for footnote A), Class F except that loss on ignition shall not exceed 4.0 percent.

H. Dowels: ASTM A 36 steel bars ½ inch diameter by 5 inches long, unless otherwise indicated on the Drawings.

2.02 PROPORTIONING OF CONCRETE MIXES

A. See Section 03300 Class A.

2.03 FABRICATION OF ANCHOR BOLT ASSEMBLIES

A. Bolts: Diameter 1/8 inch less than the bolt holes in the equipment supports and length equal to the depth of the pad minus 1 inch plus the additional length required to provide full thread through nuts after shims, equipment, and washers are in place.

B. Sleeves: Diameter 1/2 inch larger than the bolt diameter and length as required to extend from the head of the bolt to the top of the pad.

C. Plates: 3 x 3 x 1/4 inch steel plate.

D. Weld a plate to the head end of a bolt. Center the bolt in a sleeve and tack-weld the sleeve to the plate.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Concrete materials, reinforcement, forms, and earth which will be in contact with fresh concrete shall be free from frost at the time of concrete placement.

3.02 INSTALLING ANCHOR BOLTS AND SLEEVES

A. Install anchor bolts (with sleeves) for all bolt holes in equipment supports.

B. Accurately position and securely support anchor bolts and sleeves prior to placing concrete. Support head of bolt 1 inch above bottom of pad. Temporarily close open end of sleeves to prevent entry of concrete.

C. Grout anchor bolts in sleeves with cement grout or approved shrink-resistant grout after final positioning.

3.03 REINFORCING

A. Except where other reinforcement is shown on the Drawings, install welded wire fabric at mid-depth of each pad, extending to 1 inch from perimeter of pad.

3.04 FINISHES

A. Formed Surfaces: Provide a smooth rubbed finish, with rounded or chamfered external corners, on all concrete surfaces exposed to view.

B. Unformed Surfaces: Provide a troweled finish on top surface of pads.

++ END OF SECTION ++

++ NO TEXT ON THIS PAGE ++

SECTION 15406

THERMOMETERS AND GAUGES FOR PLUMBING SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Thermometers

B. Thermometers for measuring liquid temperature

1.02 RELATED SECTIONS

A. Valves for Plumbing Systems: Section 15400.

1.03 SUBMITTALS

A. Product Data: Manufacturer's catalog sheets, specifications and installation instructions for each item specified.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Where Federal, NSF, ASME or other standards are indicated or required, products shall meet or exceed the standards established for material, quality, manufacture and performance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Dresser Instruments.

B. Marsh Bellofram.

C. Moeller Instrument Co.

D. Taylor Precision Products.

E. H.O. Trerice Co.

F. Weksler Instruments Corp.

2.02 THERMOMETERS

A. General Design Features:

1. Scale Ranges: 1-1/2 times actual working temperature required for the particular application, as approved.
    a. Maximum of two degrees between graduations and ten degrees between numerals.
    b. When scale ranges are in excess of 100 degrees, maximum range between numerals may be 20 degrees, or as otherwise approved for the particular application.
2. Direct Reading Thermometers: Bimetallic actuated, dial type, straight pattern, angle pattern, or adjustable angle pattern as required.
3. Remote Reading Thermometers: Vapor tension actuated, or gas actuated type, with extension capillary tube of length as required for the particular application.
    a. Case type as required for the particular mounting application.
4. Thermometers for Sensing Liquid Temperature: Furnish with separable sockets.
    a. Sockets for Use in Insulated Piping, Insulated Tanks or Similar Equipment: Extension lagging neck type, of length as required to compensate for insulation thickness, and proper immersion..

2.03 THERMOMETERS FOR MEASURING LIQUID TEMPERATURE

A. Bimetallic Actuated Thermometers: Comply with ASME B40.3, Accuracy Grade A.
    1. Construction: Type 304 stainless steel, all welded construction, with clear acrylic plastic or shatterproof glass crystal.
    2. Dial: White enamel background with bold black figures and graduations.
    3. Head Size:
        a. Installation in Piping: 3 inch diameter.
        b. Installation in Tanks and Similar Equipment: 5 inch diameter.
    4. Stem: Length as required for proper immersion, and to compensate for insulation thickness, with threaded connection for socket.
    5. External Calibration Device.
    6. Separable Socket:
        a. Water Service: Brass or bronze.

B. Vapor Tension or Gas Actuated Capillary Thermometers: Adjustable type, with micrometer type pointer or external calibration device, of design and materials as follows:
    1. Case and Ring: Stainless steel or non-ferrous material as approved, with clear acrylic or shatterproof glass lens. Provide case of type as required for the particular mounting application. Case adjustable, allowing rotation of 360°, and stem adjustment of at least 180°. Provide set screw for locking case in desired position.
    2. Movement: Brass with bronze bearings.
    3. Dial: White enamel background, with bold black graduations, numerals and pointer; 3-1/2 inch diameter.
    4. Capillary: Stainless steel.
    5. Bulb: Copper with union well connection.
    6. Separable Socket:

a. Water Service: Brass or bronze.

PART 3 EXECUTION

3.01 INSTALLATION

A. Thermometers:
   1. Install in accordance with the manufacturer's printed installation instructions.
   2. Install direct reading thermometers, when the application requires installation 6 feet or less above the floor or bottom of space in which installed, and remote reading type when the installation is over 6 feet.

++ END OF SECTION ++

++ NO TEXT ON THIS PAGE ++

SECTION 15407

IDENTIFICATION FOR PLUMBING PIPING AND VALVES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe markers and accessories

B. Pipe service identification tags

C. Valve service identification tags

D. Valve service identification chart frames

1.02 REFERENCES

A. ANSI A13.1 - Scheme for Identification of Piping Systems.

1.03 SUBMITTALS

A. Product Data: Catalog sheets, specifications and installation instructions for each item specified.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. W.H. Brady Co., Milwaukee, WI.

B. Emed Co., Buffalo, NY.

C. Panduit Corp., Tinley Park, IL.

D. Seton Nameplate Corp., New Haven, CT.

2.02 PIPE MARKERS AND ACCESSORIES

A. Snap-on Marker: One piece wrap around type constructed of precoiled acrylic plastic with clear polyester coating, integral flow arrows, legend printed in alternating directions, 3/4 inch adhesive strip on inside edge, and 360 degree visibility.

B. Strap-On Marker: Strip type constructed of precoiled acrylic plastic with clear polyester coating, integral flow arrows, legend printed in alternating directions, factory applied grommets, and pair of stainless steel spring fasteners.

C. Stick-On Marker: Pressure sensitive adhesive backed type constructed of vinyl with clear polyester coating, and integral flow arrows for applications where flow arrow banding tape is not being used.

D. Pipe Marker Legend and Color Field Sizes:

OUTSIDE DIAMETER OF PIPE OR INSULATION (Inches)	LETTER SIZE (Inches)	LENGTH OF COLOR FIELD (Inches)
3/4 to 1-1/4	1/2	8
1-1/2 to 2	3/4	8
2-1/2 to 6	1-1/4	12
8 to 10	2-1/2	24
Over 10	3-1/2	32

E. Banding Tapes: Pressure sensitive adhesive backed type constructed of vinyl with clear polyester coating.
   1. Plain Tape: Unprinted type; color to match pipe marker background.
   2. Flow Arrow Tape: Printed type with integral flow arrows; color to match pipe marker background.

F. Pipe Size Labels: Pressure sensitive adhesive backed type constructed of vinyl with clear polyester coating, vertical reading pipe size in inches, and legend size matching adjacent pipe marker.

2.03 PIPE SERVICE IDENTIFICATION TAGS

A. Type: No. 19 B & S gage brass, with 1/4 inch high pipe service abbreviated legend on one line, over 1/2 inch high pipe size legend in inches, both deep stamped and black filled; and 3/16 inch top hole for fastener.

B. Size: 2 inch square tag.

C. Fasteners: Brass "S" hook or brass jack chain of size as required for pipe to which tag is attached.

2.04 VALVE SERVICE IDENTIFICATION TAGS

A. Type: No. 19 B & S gage brass, with 1/4 inch high valve service abbreviated lettering on one line over 1/2 inch high valve service chart number, both deep stamped and black filled; and with 3/16 inch top hole for fastener.

B. Size: 1-1/2 inch hexagon.

C. Fasteners: Brass "S" hook or brass jack chain of size as required for valve stem or handle to which tag is attached.

2.05 VALVE SERVICE IDENTIFICATION CHART FRAMES

A. Type: Satin finished extruded aluminum frame with rigid clear plastic glazing, size to fit 8-1/2 x 11 inches valve chart.

PART 3 EXECUTION

3.01 PREPARATION

A. Complete testing, insulation and finish painting work prior to completing the Work of this Section.

B. Clean pipe surfaces with cleaning solvents prior to installing piping identification.

C. Remove dust from insulation surfaces with clean cloths prior to installing piping identification.

3.02 INSTALLATION

A. Install the Work of this Section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.

B. Stick-On Pipe Markers:
   1. Install minimum of 2 markers at each specified location, 90 degrees apart on visible side of pipe.
   2. Encircle ends of pipe markers around pipe or insulation with banding tape with one inch lap. Use plain banding tape on markers with integral flow arrows, and flow arrow banding tape on markers without integral flow arrows.

C. Pipe Size Labels: Install labels adjacent to each pipe marker and upstream from flow arrow. Install a minimum of 2 pipe size labels at each specified location, 90 degrees apart on visible side of pipe.

D. Pipe Service Identification Tags: Attach tags to piping being identified with "S" hooks or jack chains.

3.03 PIPING IDENTIFICATION SCHEDULE

A. Piping Identification Types:
   1. Piping or Insulation under 3/4 inch od: Pipe identification tags.
   2. Piping or Insulation 3/4 inch to 5-7/8 inch od: Snap-on marker or stick-on marker.
   3. Piping or Insulation 6 inch od and Larger: Strap-on marker or stick-on marker.

B. Identify exposed piping, bare or insulated, as to content, size of pipe and direction of flow, with the following exceptions:
   1. Piping in non-walk-in tunnels or underground conduits between manholes.
   2. Piping in furred spaces or suspended ceilings, except at valve access panels where valves and piping shall be identified as specified for exposed piping systems.
   3. Piping in finished spaces such as offices, class rooms, wards, toilet rooms, shower rooms and spaces as specified.

C. Locate piping identification to be visible from exposed points of observation.
   1. Locate piping identification at valve locations; at points where piping enters and leaves a partition, wall, floor or ceiling, and at intervals of 20 feet on straight runs.
   2. Where 2 or more pipes run in parallel, place printed legend and other markers in same relative location.

3.04 VALVE IDENTIFICATION SCHEDULE

A. Valve Service Identification Tags:
   1. Tag control valves, except valves at equipment, with a brass tag fastened to the valve handle or stem, marked to indicate service and numbered in sequence for the following applications:
      a. Domestic water valves controlling mains, risers and branch runouts.
      b. Gas valves controlling mains, risers, and branch runouts.
      c. Valves in sprinkler and fire standpipe systems, except hose valves.

B. Valve Service Identification Charts:
   1. Provide 2 framed valve charts for each piping system specified to be provided with valve identification tags. Type charts on 8-1/2 x 11 inches heavy white bond paper, indicating valve number, service and location.
   2. Hang framed charts at locations as directed.

++END OF SECTION++

SECTION 15410

PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Domestic water piping and fittings

B. Sanitary and storm piping and fittings

1.02 RELATED SECTIONS

A. Joint Sealants: Section 07920.

B. Valves for Plumbing Systems: Section 15400.

1.03 SUBMITTALS

A. Product Data:
   1. Catalog sheets and specifications indicating manufacturer name, type, applicable reference standard, schedule, or class for specified pipe and fittings.
   2. Material Schedule: Itemize pipe and fitting materials for each specified application in Pipe and Fittings Schedule in Part 3 of this Section. Where optional materials are specified indicate option selected.

B. Quality Control Submittals
   1. Copy of hydraulic press fitting manufacturer's printed field inspection procedures for hydraulic press joints in domestic tubing.

PART 2 PRODUCTS

2.01 STEEL PIPE AND FITTINGS

A. Steel Pipe for Threading: Standard weight, Schedule 40, black or galvanized; ASTM A 53 or ASTM A 135.

B. Cast Iron Fittings:
   1. Drainage Pattern, Threaded: ASME B16.12.

2.02 COPPER AND BRASS PIPE, TUBING AND FITTINGS

A. Copper Tube, Types K, L, and M: ASTM B 88.

B. Wrot Copper Tube Fittings, Solder Joint: ASME B16.22.

C. Cast Copper Alloy Tube Fittings, Solder Joint: ASME B16.18.

D. Drainage Tube, Type DWV: ASTM B 306.

E. Wrot Copper Drainage Tube Fittings, Solder Joint: ASME B16.29.

F. Cast Copper Alloy Drainage Fittings, Solder Joint: ASME B16.23.

G. Unions: Cast bronze, 150 lb Class, bronze to bronze seats, threaded or solder joint.

H. Plumber's Tube: Seamless, semi-annealed, minimum 65 percent copper, No. 18 B & S Gage.

I. Flared Tube Fittings:
   1. Water Tube Type: ASME B16.26.

J. Flanges: Conform to the Standards for fittings used in systems.
   1. Brazing Flanges: ASME B16.24, hubs modified for brazing ends.

2.03 HYDRAULIC PRESS FITTINGS FOR COPPER TUBING

A. Acceptable Fittings:
   1. ProPress by Viega, 301 N. Main, Wichita, KS 67202, (877) 843-4262, www.viega.com.
   2. Operating Conditions:
      a. Maximum Operating Pressure: 200 psi.
      b. Operating Temperature Range: 0-250 degrees F.
      c. Maximum Test Pressure: 600 psi.
      d. Maximum Vacuum: 29.2 inches hg @ 68 degrees F.
   3. Features:
      a. Fittings: Copper and copper alloy conforming to material requirements of ASME B16.18 or ASME B16.22.
         1) Stainless Steel Grip Ring: Adds strength to the joint without collapsing the interior passageway
      b. No flame for soldering required for installation of fittings and valves.
      c. Unpressed connections identified during pressure testing when water flows past sealing element.
      d. Sealing Elements: Factory installed, EPDM.
      e. Fittings that have been pressed can be rotated. If rotated more than 5 degrees, the fitting must be repressed to restore its resistance to rotational movement.
      f. Extended fitting end lead allows for twice the retention grip surface, and assists with proper tube alignment.
      g. Soldered adapter fittings are not allowed.

2.04 CAST IRON PIPE AND FITTINGS

A. Bell and Spigot Soil Pipe: Service Weight, Bitumin coated; ASTM A 74.

B. Bell and Spigot Soil Pipe Fittings: Service Weight, Bitumin coated; ASTM A 74.

C. Hubless Pipe: Bitumin coated; Cast Iron Soil Pipe Institute Standard No. 301.

D. Hubless Pipe Fittings: Drainage Pattern, Bitumin coated; Cast Iron Soil Pipe Institute Standard No. 301.

E. Hubless Joint Couplings: Stainless steel shield and clamp assembly, and elastomer sealing sleeve; CISPI-310.

2.05 COUPLINGS AND FITTINGS FOR GROOVED END PIPE

A. Couplings: Grinnell Corp.'s Rigidlok Fig. 7401, or Victaulic Co.'s Style 107, having minimum pressure rating of:
   1. 750 psi from 1-1/2 inch to 4 inch.
   2. 700 psi for 6 inch.
   3. 600 psi for 8 inch.
   4. Couplings: Gustin-Bacon Inc.'s No. 100 Gruvagrips, or Victaulic Co.'s Style 77, having pressure rating of:
      a. 1000 psi for 3/4 inch to 6 inch.
      b. 800 psi for 8 inch to 12 inch.
      c. 300 psi for 14 inch to 24 inch.
   5. Fittings: By same manufacturer as couplings, having pressure ratings equal to or greater than couplings. Comply with the following standards:
      a. Steel: ASTM A 53 or A 106, Grade B.
      b. Malleable Iron: ASTM A 47.
      c. Ductile Iron: ASTM A 536.

2.06 JOINING AND SEALANT MATERIALS

A. Thread Sealant:
   1. LA-CO Industries', Slic-Tite Paste with Teflon.
   2. Loctite Corp.'s No. 565 Thread Sealant.
   3. Thread sealants for potable water shall be NSF approved.

B. Solder: Solid wire type conforming to the following:
   1. Type 3: Lead-free tin-silver solder (ASTM B 32 Alloy Grade E, AC, or HB); Engelhard Corp.'s Silvabrite 100, Federated Fry Metals' Aqua Clean, or J.W. Harris Co. Inc.'s Stay-Safe Bridgit.

C. Soldering Flux for Soldered Joints: All-State Welding Products Inc.'s Duzall, Engelhard Corp.'s General Purpose Liquid or Paste, Federated Fry Metals' Water Flow 2000, or J.W. Harris Co. Inc.'s Stay-Clean.

E. Joint Packing:
   1. Oiled Oakum: Manufactured by Nupak of New Orleans, Inc., 931 Daniel St., Kenner, LA 70062, (504) 466-1484.

2. Acid Resistant Joint Packing: Sealite Inc.'s Red Stripe, Asbestos-Free Acid-Resistant White Oakum, No. 312.

F. Gaskets For Use With Ductile Iron Water Pipe and Cast Iron Drainage Pipe: Synthetic rubber rings (molded or tubular): Clow Corp.'s Belltite, Tyler Pipe Industries Inc.'s Ty-Seal, or U.S. Pipe and Foundry Co.'s Tyton.

G. Flange Gasket Material:
1. For Use with Cold Water: 1/16 inch thick rubber.
2. For Use with Hot Water, or Air : Waterproofed non-asbestos ceramic or mineral fiber, or a combination of metal and water-proofed non-asbestos ceramic or mineral fiber, designed for the temperatures and pressures of the piping systems in which installed.

H. Gaskets For Use With Grooved End Pipes and Fittings: Type and materials as recommended and furnished by the fitting manufacturer, for the service of piping system in which installed.

2.07 PACKING MATERIALS FOR BUILDING CONSTRUCTION PENETRATIONS

A. Oiled Oakum: Manufactured by Nupak of New Orleans, Inc., 931 Daniel St., Kenner, LA 70062, (504)466-1484.

2.08 DIELECTRIC CONNECTORS

A. Dielectric Fitting: Bronze ball valve with end connections and pressure rating to match associated piping.
1. Nipples with inert non-corrosive thermoplastic linings are not acceptable.
2. Flange Electrical Insulation Kit: Consisting of dielectric sleeves and washers, and dielectric gasket.
a. Rated 150 psi at 250 degrees F: ANSI Class 150, full faced neoprene gasket with bolt holes, double phenolic washers, and mylar sleeves; Model 150 by APS, Lafayette, LA 70596, (337) 233-6116.

2.09 PIPE SLEEVES

A. Type A: Schedule 40 steel pipe.

B. Type B: No. 16 gage galvanized sheet steel.

C. Type C: Schedule 40 steel pipe with 1/4 inch steel collar continuously welded to pipe sleeve. Size steel collars as required to span a minimum of one cell or corrugation, on all sides of the rough opening thru the metal deck.

D. Type D: No. 16 gage galvanized sheet steel with 16 gage sheet steel metal collar rigidly secured to sleeve. Size metal collars as required to span a minimum of one cell or corrugation, on all sides of the rough opening thru the metal deck.

2.10 FLOOR, WALL AND CEILING PLATES

A. Cast Brass: Solid type with polished chrome plated finish, and set screw.
   1. Series Z89 by Zurn, 929 Riverside Drive, Grosvenordale, CT 06255, (800) 243-1830.
   2. Model 127XXXX by Maguire Mfg., Cheshire CT 06410, (203) 699-1801.
   3. Stamped Steel: Split type, polished chrome plated finish, with set screw.
      a. Figures 2 and 13 by Anvil International, Portsmouth, NH 03802, (603) 422-8000.
   4. Cast Iron or Malleable Iron: Solid type, galvanized finish, with set screw:
      a. Model 395 by Anvil International, Portsmouth, NH 03802, (603) 422-8000.
      b. Model 900-016XX by Landsdale International, Westville, NJ 08093, (800) 908-0523.

2.11 FLEXIBLE CONNECTIONS

A. Underground Application:
   1. Acceptable Companies:
      a. Titeflex Inc., Springfield, MA.
      b. Flex-ing, Sherman, TX.
   2. Features:
      a. Construction: Stainless steel innercore covered with braided Type 304 stainless steel outer jacket.
      b. Permanently crimped stainless steel collars with one threaded end and one threaded swivel end.

B. Underground or Above Ground Application:
   1. Acceptable Companies:
      a. Titeflex Inc., Springfield, MA.
      b. Flex-ing, Sherman, TX.
   2. Features:
      a. Construction: Convoluted, Type 321 stainless steel inner core, minimum .012 inch wall thickness covered with braided Type 304 stainless steel outer jacket.
      b. UL listed for above ground and underground use.
      c. Factory installed male swivel on one end.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install piping at approximate locations indicated, and at maximum height.

B. Install piping clear of door swings, and above sash heads.

C. Make allowances for expansion and contraction.

D. Allow for a minimum of one inch free air space around pipe or pipe covering, unless otherwise specified.

E. Install horizontal piping with a constant pitch, and without sags or humps.
   1. Water Piping: Pitch 1/4 inch per 10 feet upward in direction of flow, unless otherwise noted. If it is not possible to maintain constant pitch, establish a new low point and continue. At the low point, provide a 1/2 inch drip leg and gate valve with a hose bibb end. Provide an air vent at the high point.
   2. Drainage Piping: Pitch 1/4 inch per foot downward, in direction of flow, unless otherwise noted.
   3. Vent Piping: Pitch 1/4 inch per foot upward, unless otherwise noted.

F. Install vertical piping plumb.

G. Use fittings for offsets and direction changes, except for Type K soft annealed copper temper water tube.

H. Cut pipe and tubing ends square; ream before joining.

3.02 DRAINAGE SYSTEMS

A. Fittings:
   1. Use long turn drainage pattern fittings, unless space conditions prohibit their use; in such cases, short turn pattern fittings may be used.
   2. Vertical Offsets: Make vertical offsets with 45 degree elbows, or 1/8 bends.
   3. Tucker Fittings: Tucker fittings may only be installed in vertical piping.

B. Cleanouts:
   1. Install cleanouts with sufficient side and end clearance to allow for the removal of the cleanout plug, and the use of cleaning tools.
   2. Lubricate cleanout plugs with anti-seize lubricant.

3.03 DOMESTIC WATER PIPING SYSTEM

A. Connect runouts to the upper quadrant of the main, and run upward at not less than 45 degrees before extending laterally.

B. Make final connections to plumbing fixtures and equipment with unions, or flanges:
   1. Do not use unions in ferrous piping larger than 3 inches.
   2. Do not use unions in brass or copper piping larger than 2 inches.

3.04 PIPE JOINT MAKE-UP

A. Soldered Joint: Thoroughly clean tube end and inside of fitting with emery cloth, sand cloth, or wire brush. Apply flux to the pre-cleaned surfaces. Install fitting, heat to soldering temperature, and join the metals with type solder specified. Remove residue.

B. Flanged Pipe Joint:
   1. Install threaded companion flanges on steel pipe; flanges on galvanized pipe are not required to be galvanized.
   2. Provide a gasket for each joint.

a. Hot Water Pipe Gasket: Coat with a thin film of oil before making up joint.
b. Air Pipe Gasket: Coat with a thin film of oil before making up joint.

3. Coat bolt threads and nuts with anti-seize lubricant before making up joint.

C. Calked Joint: Pack hub with joint packing specified, and calk. Run 12 ounces molten lead for each inch of pipe diameter. Calk cooled lead ring and face off smoothly.

D. Rubber Ring Push-on Joint: Clean hub, bevel spigot, and make up joint with lubricated gasket in conformance with the manufacturer's printed installation instructions.

E. Grooved Pipe Joint: Roll groove pipe ends, make up joint with grooved end fittings and couplings, in conformance with the manufacturer's printed installation instructions.
1. Cut grooved end piping is not acceptable.

F. Hubless CI Pipe Joint: Make up joint with hubless fitting and couplings, in conformance with the manufacturer's printed installation instructions.

G. Mechanical Joint: Make up joint in conformance with the manufacturer's printed installation instructions, with particular reference to tightening of bolts.

H. Hydraulic Pressed Joint: Follow manufacturer's printed installation instructions.

I. Dissimilar Pipe Joint:
1. Joining Bell and Spigot and Threaded Pipe: Install a half coupling on the pipe or tube end to form a spigot, and calk into the cast iron bell.
2. Joining Dissimilar Threaded Piping: Make up connection with a threaded coupling or with companion flanges.
3. Joining Dissimilar Non-Threaded Piping: Make up connection with adapters recommended by the manufacturers of the piping to be joined.
4. Joining Galvanized Steel Pipe and Copper Tubing: Make up connection with a dielectric connector.
5. Joining FRP and Threaded Pipe: Make up connection with adapters as recommended by manufacturers of piping being joined.

3.05 PIPING PENETRATIONS

A. Sleeve Schedule: Unless otherwise shown, comply with the following schedule for the type of sleeve to be used where piping penetrates wall or floor construction:

1. CONSTRUCTION	SLEEVE TYPE
a. Frame construction.	None Required
b. Foundation walls.	A*
c. Non-waterproof interior walls.	B*
d. Non-waterproof interior floors on metal decks.	D*
e. Non-waterproof interior floors not on metal decks.	B*
f. Floors not on grade having a floor drain.	A

g.	Floors over mechanical equipment, steam service, machine, and boiler rooms.	A
h.	Floors finished or to be finished with latex composition or terrazzo, and on metal decks.	D*
i.	Floors finished or to be finished with latex composition or terrazzo, and not on metal decks.	A
j.	Earth supported concrete floors.	None Required
k.	Exterior concrete slabs on grade.	A
l.	Fixtures with floor outlet waste piping.	None Required
m.	Metal roof decks.	C
n.	Non-metal roof decks.	A
o.	Waterproof floors on metal decks.	D
p.	Waterproof floors not on metal decks.	A
q.	Waterproof walls.	A

B. Diameter of Sleeves and Core Drilled Holes:
   1. Unless otherwise specified, size holes thru floors and walls in accordance with the through penetration fire stopping system being used.
   2. Size holes thru exterior walls or waterproofed walls above inside earth or finished floors, and exterior concrete slabs in accordance with the following:
      a. Uninsulated (Bare) Pipe: Inside diameter of sleeve or core drilled hole 1/2 inch greater than outside diameter of pipe, unless otherwise specified.
      b. Insulated Pipe: Inside diameter of sleeve or core drilled hole 1/2 inch greater than outside diameter of insulation, unless otherwise specified.
      c. Mechanical Modular Seals: Size holes in accordance with the manufacturer's recommendations.
   3. Size holes for sprinkler and fire standpipe piping in accordance with NFPA 13.

C. Length of Sleeves (except as shown otherwise on Drawings):
   1. Walls and Partitions: Equal in length to total finished thickness of wall or partition.
   2. Floors with Finish: Equal in length to total finished thickness of floor and extending 1/2 inch above the finished floor level, except as follows:
      a. In furred spaces at exterior walls, extend sleeve one inch above the finished floor level.
   3. Exterior Concrete Slabs: Equal in length to total thickness of slab and extending 1/2 inch above the concrete slab.
   4. Roofs: Equal in length to the total thickness of roof construction, including insulation and roofing materials, and extending one inch above the finished roof level.

D. Packing of Sleeves and Core Drilled Holes:

1. Pack sleeves in exterior walls or waterproofed walls above inside earth or finished floors with oakum to within 1/2 inch of each wall face, and finish both sides with Type 1C (one part) sealant. See Section 07920.
    a. Mechanical modular seals may be used in lieu of packing and sealant for sleeves and core drilled holes.
3. Pack sleeves in exterior concrete slabs with oakum to full depth, and within 1/2 inch of top of sleeve and finish the remainder with sealant. See Section 07920.
    a. Sealant Types:
        1) Piping Conveying Materials up to 140 degrees F other than Motor Fuel Dispensing System Piping: Type 1C (one part).
    b. Mechanical modular seals may be used in lieu of packing and sealant for sleeves and core drilled holes.

E. Weld metal collars of Type C and D sleeves to the upper surface of the metal deck. Seal voids under the metal collar as recommended by the manufacturer of the metal deck.

3.06 FLOOR, WALL AND CEILING PLATES

A. Install plates for exposed uninsulated piping passing thru floors, walls, ceilings, and exterior concrete slabs as follows:
    1. In Finished Spaces:
        a. Piping 4 Inch Size and Smaller: Solid or split, chrome plated cast brass.
        b. Piping Over 4 Inch Size: Split, chrome plated cast brass.
        c. Unfinished Spaces (Including Exterior Concrete Slabs): Solid, unplated cast iron.
        d. Fasten plates with set screws.
        e. Plates are not required in pipe shafts or furred spaces.

3.07 PIPE AND FITTING SCHEDULE

A. Where options are given, choose only one option for each piping service. No deviations from the selected option will be allowed.

B. Domestic Water (Above Ground):
    1. 3 inch and Under: Type L hard drawn copper tube, with cast copper alloy or wrot copper solder type fittings, and joints made up with Type 3 solder, or hydraulic press joints.

C. Domestic Water (Below Ground):
    1. 2-1/2 inches and Under: Type K soft annealed copper tube with water tube type flared fittings.

D. Drainage (Sanitary) Above Ground:
    1. Service weight, coated, cast iron bell and spigot pipe and fittings with calked joints.

2. Service weight, coated, cast iron bell and spigot pipe and fittings with rubber ring push-on joints.
3. Hubless, coated, cast iron pipe, fittings, and joint couplings.
4. DWV copper tubing, with cast brass or wrot copper drainage pattern fittings, and joints made with Type 3 solder.

E. Drainage (Storm) Above Ground:
1. Service weight, coated, cast iron bell and spigot pipe and fittings, with calked joints.
2. Service weight, coated, cast iron bell and spigot pipe and fittings, with rubber ring push-on joints.
3. Hubless, coated, cast iron pipe, fittings and joint couplings.

F. Drainage Piping (Below Ground):
1. Option No. 1: Service weight, coated, cast iron bell and spigot pipe and fittings, with calked joints.
2. Option No. 2: Service weight, coated, cast iron bell and spigot pipe and fittings, with rubber ring push-on joints.

G. Vent Piping: Same materials that are used for piping system to which vent is connected.

++ END OF SECTION ++

SECTION 15411

DOMESTIC WATER SUPPLY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water hammer arrestors

B. Drain valve

C. Fasteners

1.02 SUBMITTALS

A. Product Data: Catalog sheets, specifications, dimensional data, and installation instructions for each item specified, excluding fasteners.

1.03 MAINTENANCE

A. Special Tools: Deliver to the Owner's Representative.
   1. Tools For Vandal Resistant Fasteners: One for each type and size.

PART 2 PRODUCTS

2.01 WATER HAMMER ARRESTORS

A. Hydropneumatically controlled with permanently sealed expansion chamber pre-charged with non-combustible gas, threaded connection, and conforming to ASME A112.26.1M - Water Hammer Arrestors, and ASSE 1010 - Water Hammer Arrestors.
   1. Bellows Type: Stainless steel construction with elastomer or stainless steel bellows.
   2. Piston Type: Hard drawn copper body with brass piston, cap and adapter; and elastomer seals.

2.02 DRAIN VALVE

A. Cast brass body with renewable units, hose bibb vacuum breaker (ASSE 1011) with drainage feature, and removable cast iron handwheel with vandal resistant fastener.
   1. Valve must be completely assembled to make hose connection.
   2. Connections: 1/2 or 3/4 inch threaded or solder end inlet, and 3/4 inch hose bibb outlet.

2.03 FASTENERS

A. Vandal Resistant Fasteners: Torx head with center pin.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.

B. Secure external components in place with vandal resistant fasteners or devices which cannot be removed without special tools.

++ END OF SECTION ++

SECTION 15412

DRAINAGE ACCESSORIES FOR PLUMBING SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cleanout plug

B. Cleanout

C. Cleanout wall plate

D. Cleanout deck plate

E. Air gap fitting

F. Indirect waste funnel

G. Fasteners

1.02 REFERENCES

A. Comply with the applicable requirements of ASME A112.36.2M - Cleanouts, and ASME A112.1.2 - Drainage Funnels and Air Gaps.

1.03 SUBMITTALS

A. Product Data: Catalog sheets, specifications, and installation instructions for each item specified except fasteners.

1.04 MAINTENANCE

A. Special Tools: Deliver the following to the Owner's Representative:
   1. Tools for Vandal Resistant Fasteners: One for each type and size.
   2. T-Handle Wrench for Cleanout Plugs: One for each type and size.

PART 2 PRODUCTS

2.01 CLEANOUT PLUG

A. Cast brass or bronze, with threaded end, and raised or countersunk head.
   1. Tapped head for attachment of cleanout wall or deck plate covers where required.

B. Anti-Seize Lubricant: Never-Seez by Bostik Chemical Group, Broadview, IL; Molycote 1000 by Dow Corning Corp, Midland, MI; Anti-Seize Lubricant by Loctite Corp, Newington, CT.

2.02 CLEANOUT

A. Threaded pipe fitting or cast iron ferrule with gas tight cleanout plug.

2.03 CLEANOUT WALL PLATE

A. Round, stainless steel or polished chrome plated bronze cover plate with stainless steel vandal resistant fastener to secure to cleanout plug.

2.04 CLEANOUT DECK PLATE

A. Standard duty floor cleanout fitting with coated cast iron body; round, polished, nickel bronze scoriated top secured to cleanout plug with stainless steel vandal resistant fastener; threaded height adjustment, cast iron head, gas tight cleanout plug, and connection to match piping option selected.

2.05 AIR GAP FITTING

A. Coated cast iron body with air gaps, set screw or threaded inlet, and outlet connection to match piping option selected.

2.06 INDIRECT WASTE FUNNEL

A. Combination Funnel Drain and P Trap: Polished chrome plated cast brass construction.
   1. Funnel: 4 inch top dia., 4 inches deep, with threaded outlet.
   2. P Trap: Bottom cleanout, threaded inlet, and outlet connection to match piping option selected.

2.07 FASTENERS

A. Corrosion Resistant Fasteners: Brass, bronze, or Type 302 or 304 stainless steel bolts.

B. Vandal Resistant Fasteners: Torx head with center pin.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.

B. Cleanout Plug: Lubricate threads with anti-seize lubricant before final installation.

C. Secure external components in place with vandal resistant fasteners or devices which cannot be removed without special tools.

++ END OF SECTION ++

SECTION 15420

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation

B. Insulation jackets

C. Adhesives, mastics, and sealers

D. Miscellaneous materials

1.02 RELATED SECTIONS

A. Painting: Section 09900.

B. Hangers and Supports for Plumbing Piping and Equipment: Section 15422.

1.03 ABBREVIATIONS

A. FS: Federal Specification.

B. K: Thermal Conductivity, i.e., maximum Btu per inch thickness per hour per square foot.

C. pcf: Pounds per cubic foot.

D. PVC: Polyvinylchloride.

1.04 SUBMITTALS

A. Product Data: Manufacturer's catalog sheets, specifications and installation instructions for the following:
   1. Insulation Materials.
   2. Jacket Materials.

B. Quality Control Submittals:
   1. Installers Qualification Data:
      a. Name of each person who will be performing the Work, and their employer's name, business address and telephone number.
      b. Furnish names and addresses of the required number of similar projects that each person has worked on which meet the qualifications.

1.05 QUALITY ASSURANCE

A. Qualifications: The persons installing the Work of this Section and their Supervisor shall be personally experienced in mechanical insulation work and shall have been regularly employed by a company installing mechanical insulation for a minimum of 5 years.

B. Regulatory Requirements:
   1. Insulation installed inside buildings, including laminated jackets, mastics, sealants and adhesives shall have a Fire Spread/Smoke Developed Rating of 25/50 or less based on ASTM E 84.
   2. Local and State Building Codes and Ordinances

PART 2 PRODUCTS

2.01 PIPING INSULATION

A. Fibrous Glass (Mineral Fiber) Insulation: Composed principally of fibers manufactured from rock, slag, or glass, with or without binders, and asbestos free.
   1. Preformed Pipe Insulation: Minimum density 3 pcf; ASTM C 547:
      a. Class 1 (Suitable for Temperatures Up to 450 degrees F): K of 0.26 at 75 degrees F.
   2. Premolded Fitting Insulation: Minimum density 4.0 pcf, K of 0.26 at 75 degrees F; ASTM C 547, Class 1.
   3. Insulation Inserts for PVC Fitting Jackets: Minimum density 1.5 pcf, K of 0.28 at 75 degrees F; ASTM C 553, Type III.
      a. Suitable for temperatures up to 450 degrees F.

B. Flexible Elastomeric Foam Insulation:
   1. FM tested and approved, meeting the following:
      a. Maximum Water Vapor Transmission: 0.10 perm - inch based on ASTM E 96, Procedure A.
      b. K of 0.27 at 75 degrees F based on ASTM C 518 or C 177.
      c. Fire Spread/Smoke Developed Rating: 25/50 or less based on ASTM E 84.
   2. Pipe Insulation: ASTM C 534, Type I.
   3. Polyethylene and polyolefin insulation is not acceptable.

C. High Density Jacketed Insulation Inserts for Hangers and Supports:
   1. For Use with Fibrous Glass Insulation:
      a. Cold Service Piping:
         1) Polyurethane Foam: Minimum density 4 pcf, K of 0.13 at 75 degrees F, minimum compressive strength of 125 psi.
      b. Hot Service Piping:
         1) Calcium Silicate: Minimum density 15 pcf, K of 0.50 at 300 degrees F; ASTM C 533.
         2) Perlite: Minimum density 12 pcf, K of 0.60 at 300 degrees F; ASTM C 610.

2. For Use with Flexible Elastomeric Foam Insulation: Hardwood dowels and blocks, length or thickness equal to insulation thickness, other dimensions as specified or required.

D. Cements:
   1. Fibrous Glass Thermal Insulating Cement: Asbestos free; ASTM C 195.
   2. Fibrous Glass Hydraulic Setting Thermal Insulating and Finishing Cement: ASTM C 449/C 449M.

2.02 INSULATION JACKETS

A. Laminated Vapor Barrier Jackets for Piping: Factory applied by insulation manufacturer, conforming to ASTM C 1136, Type I.
   1. Type I: Reinforced white kraft and aluminum foil laminate with kraft facing out.
      a. Pipe Jackets: Furnished with integral 1-1/2 inch self sealing longitudinal lap, and separate 3 inch wide adhesive backed butt strips.
   2. Laminated vapor barrier jackets are not required for flexible elastomeric foam insulation.

B. Canvas Jackets: Cotton duck, fire retardant, complying with NFPA 701, 4 oz or 6 oz per sq yd as specified.

C. Premolded PVC Fitting Jackets:
   1. Constructed of high impact, UV resistant PVC.
      a. ASTM D 1784, Class 14253-C.
      b. Working Temperature: 0-150 degrees F.

2.03 ADHESIVES, MASTICS, AND SEALERS

A. Lagging Adhesive (Canvas Jackets): Childers' CP-50AMV1, Epolux's Cadalag 336, Foster's 30-36.

B. Vapor Lap Seal Adhesive (Fibrous Glass Insulation): Childers' CP-82, Epolux's Cadoprene 400, Foster's 85-60 or 85-20.

C. Vapor Barrier Mastic (Fibrous Glass Insulation): Permeance shall be .03 perms or less at 45 mils dry per ASTM E 96. Childers' CP-34, Epolux's Cadalar 670, Foster's 30-65.

D. Adhesive (Flexible Elastomeric Foam): Armstrong's 520, Childers' CP-82, Epolux's Cadoprene 488, Foster's 85-75. 5 gallon cans only

E. Adhesive (Fiberglass Duct Liner): Childers' Chil Quick CP-127, Foster Vapor Fas 85-60. Must comply with ASTM C 916, Type II

F. Weather Barrier Breather Mastic (Reinforcing Membrane): Childers' VI-CRYL CP-10/11, Foster's Weatherite 46-50.

G. Sealant (Metal Pipe Jacket): Non hardening elastomeric sealants. Foster Elastolar 95-44, Childers Chil Byl CP-76, Pittsburgh Corning 727

H. Reinforcing Membrane: Childers' Chil Glas #10, Foster Mast a Fab, Pittsburgh Corning PC 79

2.04 MISCELLANEOUS MATERIALS

A. Pressure Sensitive Tape for Sealing Laminated Jackets:
   1. Acceptable Manufacturers: Alpha Associates, Ideal Tape, Morgan Adhesive.
   2. Type: Same construction as jacket.

B. Wire, Bands, and Wire Mesh:
   1. Binding and Lacing Wire: Nickel copper alloy or copper clad steel, gage as specified.
   2. Bands: Galvanized steel, 1/2 inch wide x 0.015 inch thick, with 0.032 inch thick galvanized wing seals.
   3. Wire Mesh: Woven 20 gage steel wire with 1 inch hexagonal openings, galvanized after weaving.

C. Reinforcing Membrane: Glass or Polyester, 10 x 10 mesh. Alpha Associates Style 59, Childer's Chil-Glas, Foster's MAST-A-FAB.

PART 3 EXECUTION

3.01 PREPARATION

A. Perform the following before starting insulation Work:
   1. Install hangers, supports and appurtenances in their permanent locations.
   2. Complete testing of piping.
   3. Clean and dry surfaces to be insulated.

3.02 INSTALLATION, GENERAL

A. Install the Work of this Section in accordance with the manufacturer's printed installation instructions unless otherwise specified.

B. Provide continuous piping insulation and jacketing when passing thru interior wall, floor, and ceiling construction.
   1. At Through Penetration Firestops: Coordinate insulation densities with the requirements of approved firestop system being installed.
      a. Insulation densities required by approved firestop system may vary with the densities specified in this Section. When this occurs use the higher density insulation.

C. Do not intermix different insulation materials on individual runs of piping.

D. All water, soil, and waste piping exposed to freezing temperatures shall be protected from freezing by insulation, heat, or both. This included piping in unheated garages, building overhangs, and exposed storm piping.

3.03 INSTALLATION AT HANGERS AND SUPPORTS

A. Reset and realign hangers and supports if they are displaced while installing insulation.

B. Install high density jacketed insulation inserts at hangers and supports for insulated piping.

C. Insulation Inserts For Use with Fibrous Glass Insulation:
   1. Where clevis hangers are used, install insulation shields and high density jacketed insulation inserts between shield and pipe.
      a. Where insulation is subject to compression at points over 180 degrees apart, e.g. riser clamps, U-bolts, trapezes, etc.; fully encircle pipe with 2 protection shields and 2 high density jacketed fibrous glass insulation inserts within supporting members.
         1) Exception: Locations where pipe covering protection saddles are specified for hot service piping, 6 inch and larger.

D. Insulation Inserts For Use with Flexible Elastomeric Foam Insulation:
   1. Where clevis hangers are used, install insulation shields with hardwood filler pieces, same thickness as adjoining insulation, inserted in undersized die cut or slotted holes in insulation at support points.
   2. Contour hardwood blocks to match the curvature of pipe, and shield.
   3. Coat dowels and blocks with insulation adhesive, and insert while still wet.
   4. Vapor seal outer surfaces of dowels and blocks with adhesive after insertion.
   5. Install filler pieces as follows:

PIPE/TUBING SIZE	FILLER PIECES	POSITION
Thru 1-1/2”	2 dowel plugs	6 o’clock; in tandem
2” thru 4”	1 block, 2 dowel plugs	6 o’clock, and 4 & 8 o’clock respectively
6” thru 8”	2 blocks, 4 dowel plugs	6 o’clock; in tandem and 4 & 8 o’clock; in tandem

3.04 INSTALLATION OF FIBROUS GLASS COLD SERVICE INSULATION

A. Install insulation materials with a field or factory applied ASTM C 1136 Type I laminated vapor barrier jacket, unless otherwise specified.

B. Piping:
   1. Butt insulation joints together, continuously seal minimum 1-1/2 inch wide self-sealing longitudinal jacket laps and 3-inch wide butt adhesive backed strips.

a. Substitution: 3 inch wide pressure sensitive sealing tape, of same material as jacket, may be used in lieu of butt strips.

2. Bed insulation in a 2-inch wide band of vapor barrier mastic, and vapor seal exposed ends of insulation with vapor barrier mastic at each butt joint between pipe insulation and equipment, fittings or flanges at the following intervals:
   a. Horizontal Pipe Runs: 21 ft.
   b. Vertical Pipe Runs: 9 ft.

C. Fittings, Valves, Flanges and Irregular Surfaces:
1. Insulate with mitre cut or premolded fitting insulation of same material and thickness as pipe insulation.
2. Secure insulation in place with 16-gage wire, with ends twisted and turned down into insulation.
3. Butt insulation against pipe insulation and bond with joint sealer.
4. Insulate valves up to and including bonnets, without interfering with packing nuts.
5. Apply leveling coat of insulating cement to smooth out insulation and cover wiring.
6. When insulating cement has dried, seal fitting, valve and flange insulation, by imbedding a layer of reinforcing membrane or 4 oz. canvas jacket between 2 flood coats of vapor barrier mastic, each 1/8 inch thick wet.
7. Lap reinforcing membrane or canvas on itself and adjoining pipe insulation at least 2 inches.
8. Trowel, brush or rubber glove outside coat over entire insulated surface.
9. Exceptions:
   a. Type C and D Insulation Material for Piping Systems: Valves, fittings and flanges may be insulated with premolded PVC fitting jackets, with fibrous glass insulation inserts.
      1) Additional insulation inserts are required for services with operating temperatures under 45 degrees F or where insulation thickness exceeds 1-1/2 inches. The surface temperature of PVC fitting jacket must not go below 45 degrees F.

3.05 INSTALLATION OF FIBROUS GLASS HOT SERVICE INSULATION

A. Install insulation materials with field or factory applied ASTM C 1136 Type I laminated vapor barrier jacket unless otherwise specified.

B. Canvas Jackets on Piping, Fittings, Valves, Flanges, Unions, and Irregular Surfaces:
1. For Piping 2 inch Size and Smaller: 4 oz per sq yd unless otherwise specified.
2. For Piping Over 2 inch Size: 6 oz per sq yd unless otherwise specified.

C. Piping:
1. Butt insulation joints together, continuously seal minimum 1-1/2 inch wide self-sealing longitudinal jacket laps and 3-inch wide adhesive backed butt strips.
   a. Substitution: 3 inch wide pressure sensitive sealing tape, of same material as the jacket, may be used in lieu of butt strips.
2. Fill voids in insulation at hanger with insulating cement.

3. Exceptions:
    a. Piping in Accessible Shafts, Attic Spaces, Crawl Spaces, Unfinished Spaces and Concealed Piping: Butt insulation joints together and secure minimum 1-1/2 inch wide longitudinal jacket laps and 3 inch wide butt strips of same material as jacket, with outward clinching staples on maximum 4 inch centers. Fill voids in insulation at hangers with insulating cement.

D. Fittings, Valves, Flanges and Irregular Surfaces:
    1. Insulate with mitre cut or premolded fitting insulation of same material and thickness as insulation.
    2. Secure in place with 16-gage wire, with ends twisted and turned down into insulation.
    3. Butt fitting, valve and flange insulation against pipe insulation, and fill voids with insulating cement.
    4. Insulate valves up to and including bonnets, without interfering with packing nuts.
    5. Apply leveling coat of insulating cement to smooth out insulation and cover wiring.
    6. After insulating cement has dried, coat insulated surface with lagging adhesive, and apply 4 oz or 6 oz canvas jacket as required by pipe size.
        a. Lap canvas jacket on itself and adjoining pipe insulation at least 2 inches.
        b. Size entire canvas jacket with lagging adhesive.
    7. Exceptions:
        a. In Types E, and F Service Piping Systems: Valves, fittings and flanges may be insulated with premolded PVC fitting jackets, with fibrous glass insulation inserts.
            1) Additional insulation inserts are required for services with operating temperatures over 250 degrees F or where insulation thickness exceeds 1-1/2 inches. The surface temperature of PVC fitting jacket must not exceed 150 degrees F.
        b. In Types E, and F Service Piping Systems: Insulate fittings, valves, and irregular surfaces 3 inch size and smaller with insulating cement covered with 4 oz or 6 oz canvas jacket as required by pipe size.
            1) Terminate pipe insulation adjacent to flanges and unions with insulating cement, trowelled down to pipe on a bevel.
        c. Fittings, Valves, Flanges, and Irregular Surfaces In Concealed Piping, Piping in Accessible Shafts, Attic Spaces, Crawl Spaces, Unfinished Rooms, Unfinished Spaces, and Tunnels: Sizing of canvas surface is not required.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC FOAM INSULATION

A. Where possible, slip insulation over the pipe, and seal butt joints with adhesive.
    1. Where the slip-on technique is not possible, slit the insulation and install.
    2. Re-seal with adhesive, making sure the mating surfaces are completely joined.

B. Insulate fittings and valves with miter cut sections. Use templates provided by the manufacturer, and assemble the cut sections in accordance with the manufacturer's printed instructions.

1. Insulate threaded fittings and valves with sleeved fitting covers. Overlap and seal the covers to the adjoining pipe insulation with adhesive.

C. Carefully mate and seal with adhesive all contact surfaces to maintain the integrity of the vapor barrier of the system.

D. Piping Exposed Exterior to a Building, Totally Exposed to the Elements:
   1. Apply flexible elastomeric foam insulation to piping with adhesive.
   2. Apply reinforcing membrane around piping insulation with adhesive or mastic.
   3. Adhesive Applied System: Apply 2 coats of finish. See Section 09900.
   4. Mastic Applied System: Apply another coat of mastic over reinforcing membrane.

3.07 INSTALLATION OF SHEET METAL JACKETING ON PIPING

A. Secure jacketing to insulated piping with preformed aluminum snap straps and stainless steel strapping installed with special banding wrench.

B. Jacket exposed insulated fittings, valves and flanges with mitred sections of aluminum jacketing.
   1. Seal joints with sealant and secure with preformed aluminum bands.

3.08 FIELD QUALITY CONTROL

A. Field Samples: The Owner's Representative, may at their discretion, take field samples of installed insulation for the purpose of checking materials and application. Reinsulate sample cut areas.

3.09 PIPING INSULATION SCHEDULE

A. Insulate all cold service and hot service piping, and appurtenances except where otherwise specified.

B. Schedule of Items Not to be Insulated:
   1. Chrome plated piping, unless otherwise specified.
   2. Exposed piping in finished spaces, serving one fixture, or piece of equipment, and which connection from the main, branch, or riser, is 24 inches or less in length.
   3. Water heater blow-off piping.
   4. Air vents, pressure reducing valves, pilot lines, safety valves, relief valves.
   5. Water meters.
   6. Piping buried in the ground, unless otherwise specified herein.
   7. Items installed by others, unless otherwise specified herein.
   8. Sanitary drainage piping, unless otherwise specified herein.
   9. Mechanical equipment with factory applied steel jacket.
   10. Hot service piping 81 degrees F to 104 degrees F.
   11. Flanges and unions in Type E, F, and G service piping systems.
   12. Sprinkler and standpipe piping, unless otherwise specified.

3.10 COLD SERVICE INSULATION MATERIAL SCHEDULE

TYPE	SERVICE AND TEMPERATURES	INSULATION MATERIAL	PIPE SIZES (INCHES)	MINIMUM (NOMINAL) INSULATION THICKNESS (INCHES)
C	Fluids (except domestic cold water) 40 F to 80 F.	Flex. Elastomeric Foam or Fibrous Glass	1-1/2 & less Over 1-1/2	1 1-1/2
D	Domestic cold water, and as specified. 33 F to 80 F.	Flex. Elastomeric Foam or Fibrous Glass	All Sizes	1/2

A. NOTES:
1. Sprinkler and Standpipe Piping (First 10 feet connected to domestic water main within building): Insulate with same materials and thicknesses specified for domestic cold water.
2. Roof Drain Bodies Below Roof, Horizontal Conductor Piping Including Drops, and First Fitting on Vertical conductor: Insulate with same materials and thicknesses specified for domestic cold water.

3.11 HOT SERVICE INSULATION MATERIAL SCHEDULE

	SERVICE AND TEMPERATURES	INSULATION MATERIAL	PIPE SIZES (INCHES)	MINIMUM (NOMINAL) INSULATION THICKNESS (INCHES)
E	Water and other fluids 105 F to140 F.	Flex. Elastomeric Foam or Fibrous Glass	1-1/2 & Less Over 1-1/2	1 2
F	Water and other fluids 141 F to 250 F.	Fibrous Glass	6 & Less 8 & Up	2 2-1/2

3.12 SCHEDULE OF METAL JACKETING FOR INSULATED PIPE

A. Piping Exterior to Building: Jacket insulated piping with circumferentially corrugated aluminum jacketing.
   1. Lap longitudinal and circumferential joints a minimum of 2 inches.
   2. Secure jacketing in place with 1/2 inch x 0.020 inch thick aluminum bands secured with aluminum wing type seals, on maximum 12 inch centers.
   3. Cover insulated fittings, valves, and offsets with mitered sections of jacketing. Seal joints with metal pipe jacket sealant, and secure with aluminum strapping and wing seals.
   4. Factory fabricated, preformed fitting covers of same material as jacketing may be used instead of mitered jacketing.
   5. Install jacketing so as to avoid trapping condensation and precipitation.

++ END OF SECTION ++

SECTION 15422

PIPE HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General support requirements for plumbing piping

B. Support requirements for cast iron piping

C. Pipe support requirements for cast-in-place concrete construction

D. Pipe support requirements for steel/concrete construction

E. Pipe hangers and supports

F. Anchors and attachments

G. Fasteners

H. Shop painting and plating

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Companion high density filler pieces for installation over the top 180 degree surface of pipe or tubing, at points of support where a combination clevis hanger, insulation shield and high density insulating saddle are installed.

1.03 RELATED SECTIONS

A. Plumbing Piping: Section 15410.

B. Plumbing Piping Insulation: Section 15420.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Details of trapeze hangers and upper hanger attachments for piping 4 inches in diameter and over. Include the number and size of pipe lines to be supported on each type of trapeze hanger.
   2. Details of pipe anchors.
   3. Details and method of installing sway braces for cast iron soil pipe.

B. Product Data: Catalog sheets, specifications and installation instructions for each item specified except fasteners.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with the applicable requirements of the ASME B31 Piping Codes.
   2. Unless otherwise shown or specified, comply with the requirements of the Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS) Standards SP-58, and SP-69.
   3. Hang and support cast iron soil pipe and fittings in accordance with the recommendations of the Cast Iron Soil Pipe's Institute's (CISPI) Cast Iron Soil Pipe and Fittings Handbook.
   4. Local and State Building Codes and Ordinances.

PART 2 PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

A. Combination clevis hanger, pipe insulation shield and vapor barrier jacketed high density insulating saddle with companion high density filler piece.
   1. Insulating saddles and filler pieces shall be of the same thickness and materials as the adjoining pipe insulation. Saddles shall cover the lower 180 degrees of the pipe or tubing, and companion filler pieces shall cover the upper 180 degrees of the pipe or tubing. Physical sizes, gages, etc. of the components of insulated hangers shall be in accordance with the following schedule:

PIPE OR TUBING SIZE (Inches)	SHIELD LENGTH (Inches)	SHIELD GAGE	SADDLE LENGTH (Inches)	VAPOR BARRIER JACKET LENGTH (Inches)
Up to 2-1/2	4	16	6	10
3 to 6	4	14	6	10
8 to 14	10	12	12	16
16 and up	10	10	12	16

B. Pipe Insulation Shields: Fabricated of steel, with a minimum arc of 180 degrees, unless otherwise indicated. Shields for use with hangers and supports, with the exception of combination clevis type hangers, shall be in accordance with the following schedule:

PIPE OR TUBING SIZE (Inches)	SHIELD LENGTH (Inches)	SHIELD GAGE
Up to 2-1/2	8	18
3 to 8	10	16
10 to 14	12	12
16 and up	18	10

C. Pipe Covering Protection Saddles: 3/16 inch thick steel, of sufficient depth for the insulation thickness specified, notched so that saddle contact with the pipe is approximately 50 percent of the total axial cross section. Saddles for pipe 12 inches in size and larger shall have a center support.

D. Pipe Hangers: Height adjustable standard duty clevis type, with cross bolt and nut.
   1. Pipe spreaders or spacers shall be used on cross bolts of clevis hangers, when supporting piping 10 inches in size and larger.

E. Adjustable Floor Rests and Base Flanges: Steel.

F. Hanger Rods: Stainless steel, fully threaded or threaded at each end, with two nuts at each end for positioning rod and hanger, and locking each in place.

G. Riser Clamps: Malleable iron or steel.

H. Rollers: Cast Iron.

2.02 ANCHORS AND ATTACHMENTS

A. Sleeve Anchors (Group II, Type 3, Class 3): Molly's Div./USM Corp. Parasleeve Series, Ramset's Dynabolt Series, or Red Head/Phillips AN, HN, or FS Series.

B. Wedge Anchors (Zinc Plated, Group II, Type 4, Class 1): Hilti's Kwik Bolt Series, Molly's Div./USM Corp. Parabolt PB Series, Ramset's Trubolt T Series, or Red Head/Phillips WS Series.

C. Self-Drilling Anchors (Group III, Type 1): Ramset's RD Series, or Red Head/Phillips S Series.

D. Non-Drilling Anchors (Group VIII, Type 1): Ramset's Dynaset DS Series, Hilti's HDI Series, or Red Head/Phillips J Series.

E. Stud Anchors (Group VIII, Type 2): Red Head/Phillips JS Series.

F. Beam Clamps: Forged steel beam clamp, with weldless eye nut (right hand thread), steel tie rod, nuts, and washers, Grinnell's Fig No. 292 (size for load, beam flange width, and rod size required).

G. Metal Deck Ceiling Bolts: B-Line Systems' Fig. B3019.

H. Continuous Slotted Type Concrete Insert, Galvanized:
   1. Load Rating 800 lbs/ft: Kindorf's D-986.
   2. Load Rating 1500 lbs/ft: Kindorf's D-980.
   3. Load Rating 3000 lbs/ft: Hohmann & Barnard's Inc. Type CS-H.
   4. Load Rating 4500 lbs/ft: Hohmann & Barnard's Inc. Type CS-HD.

I. Threaded Type Concrete Insert: Galvanized ferrous castings, internally threaded to receive 3/4 inch diameter machine bolts.

J. Wedge Type Concrete Insert: Galvanized box-type ferrous castings, designed to accept 3/4 inch diameter bolts having special wedge shaped heads.

2.03 FASTENERS

A. Bolts, Nuts, Washers, Lags, and Screws: Medium carbon steel; size and type to suit application; galvanized for high humidity locations, and treated wood; plain finish for other interior locations. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work.

2.04 SHOP PAINTING AND PLATING

A. Hangers, supports, rods, inserts and accessories used for pipe supports, unless chromium plated, cadmium plated or galvanized stainless steel shall be shop coated with metal primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper pipe or copper tubing.

B. Hanger supports for chromium plated pipe shall be chromium plated brass.

PART 3 EXECUTION

3.01 PREPARATORY WORK

A. Place inserts into construction form work expeditiously, so as not to delay the Work.

3.02 INSTALLATION

A. Do not hang or support one pipe from another or from ductwork.

B. Do not bend threaded rod.

C. Support all insulated horizontal piping conveying fluids below ambient temperature, by means of hangers or supports with insulation shields installed outside of the insulation.

D. Space hangers or supports for horizontal piping on maximum center distances as listed in the following hanger schedules, except as otherwise specified, or noted on the Drawings.

1. For Steel, and Threaded Brass Pipe:

PIPE SIZE (Inches)	MAXIMUM SPACING (Feet)
1 and under	8
1-1/4 and 1-1/2	9
2	10
2-1/2 and up	12

1. For Grooved End Steel Pipe:

PIPE SIZE (Inches)	MAXIMUM SPACING (Feet)

1-1/2 and under	7
2 through 4	10
5 and over	12

1. No pipe length shall be left unsupported between any two coupling joints.
2. For Copper Pipe and Copper Tubing:

PIPE OR TUBING SIZE (Inches)	MAXIMUM SPACING (Feet)
1-1/2 and under	6
2 and over	10

1. For Plastic Tubing:

PIPE OR TUBING SIZE (Inches)	MAXIMUM SPACING (Feet)
Under 2 inch	3
2 inch and over	4

1. Cast Iron Soil Pipe:
   a. General:
      1) Where piping is suspended on centers in excess of 18 inches by means of non-rigid hangers, provide sway bracing to prevent horizontal pipe movement.
      2) Additionally, brace piping 5 inches and larger to prevent horizontal movement and/or joint separation. Provide braces, blocks, rodding or other suitable method at each branch opening, or change of direction
   b. For Bell & Spigot Cast Iron Soil Pipe: Space hangers or support pipe at each joint or on maximum centers of 5 feet. Place hangers or supports as close as possible to joints and when hangers or supports do not come within 1 foot of a branch line fitting, install an additional hanger or support at the fitting.
   c. For Hubless Cast Iron Soil Pipe: Space hangers or support pipe at each joint or on maximum centers of 5 feet. Place hanger or supports as close as possible to joints and when hangers or supports do not come within 1 foot of a branch line fitting, install an additional hanger or support at the fitting.
2. For Directional Changes: Install a hanger or support close to the point of change of direction of all pipe runs in either a horizontal or vertical plane.
3. For Concentrated Loads: Install additional hangers or supports, spaced as required and directed, at locations where concentrated loads such as in-line pumps, valves, fittings or accessories occur, to support the concentrated loads.
4. For Branch Piping Runs and Runouts Over 5 feet In Length: Install a minimum of one hanger, and additional hangers if required by the hanger spacing schedules.
5. Parallel Piping Runs: Where several pipe lines run parallel in the same plane and in close proximity to each other, trapeze hangers may be submitted for approval. Base hanger spacing for trapeze type hangers on the smallest size of pipe being supported. Design the entire hanger assembly based on a safety factor of five, for the ultimate strength of the material being used.

6. Support floor drain traps from the overhead construction, with hangers of type and design as required and approved. Overhead supports are not required for floor drain traps installed directly below earth supported concrete floors.

D. Size hanger rods in accordance with the following:

PIPE OR TUBING SIZE (Inches)	SINGLE ROD HANGER SIZE (Inches)		DOUBLE ROD HANGER SIZE (Inches)	
	PIPE	TUBING	PIPE	TUBING
1/2 to 2	3/8	1/4	3/8	1/4
2-1/2 and 3	1/2	3/8	3/8	1/4
4 and 5	5/8	1/2	1/2	3/8
6	3/4	1/2	5/8	1/2
8, 10 and 12	7/8	5/8	3/4	5/8

1. Size hanger rods, for piping over 12 inches in size and multiple line supports, based on a safety factor of five for the ultimate strength of the materials being used.
2. Secure hanger rods as follows: Install one nut under clevis, angle or steel member; one nut on top of clevis, angle or steel member; one nut inside insert or on top of upper hanger attachment and one nut and washer against insert or on lower side of upper hanger attachment. A total of four nuts are required for each rod, two at upper hanger attachment and two at hanger.

E. Vertical Piping:
1. Support vertical risers of piping systems, by means of heavy duty hangers installed close to base of pipe risers, and by riser clamps with extension arms at intermediate floors, with the distance between clamps not to exceed 25 feet, unless otherwise specified. Support pipe risers in vertical shafts equivalent to the aforementioned. Install riser clamps above floor slabs, with the extension arms resting on floor slabs. Provide adequate clearances for risers that are subject to appreciable expansion and contraction, caused by operating temperature ranges.
2. Support extension arms of riser clamps, secured to risers to be insulated for cold service, 4 inches above floor slabs, to allow room for insulating and vapor sealing around riser clamps.
3. Support cast iron risers, by means of heavy duty hangers installed close to the base of the pipe risers, and 1/4 inch thick malleable iron or steel riser clamps with extension arms at each floor level, with the distance between clamps not to exceed 25 feet. Support cast iron risers in vertical shafts equivalent to the aforementioned.
4. Support hubless cast iron risers, by means of heavy duty hangers installed close to the base of the pipe risers, and by malleable iron or steel riser clamps with the extension arms at each floor level, with the distance between clamps or intermediate supports not to exceed 12 feet. Support risers in vertical shafts equivalent to the aforementioned.

F. Floor Supports: Install adjustable yoke rests with base flanges, for the support of piping, unless otherwise indicated on the Drawings. Install supports in a manner, which will not be detrimental to the building structure.

G. Underground Pipe Supports: Firmly bed pipe laid underground, on solid ground along bottom of pipe. Install masonry piers for pipe laid in disturbed or excavated soil or where suitable bearing cannot be obtained. Support pipe, laid proximate to building walls in disturbed or excavated soil, or where suitable bearing cannot be obtained, by means of wall brackets or hold-fasts secured to walls in an approved manner.

3.03 UPPER HANGER ATTACHMENTS

A. General:
   1. Secure upper hanger attachments to overhead structural steel, steel bar joists, or other suitable structural members.
   2. Do not attach hangers to steel decks that are not to receive concrete fill.
   3. Do not attach hangers to precast concrete plank decks less than 2-3/4 inches thick.
   4. Do not use flat bars or bent rods as upper hanger attachments.

B. Attachment to Steel Frame Construction: Provide intermediate structural steel members where required by pipe support spacing. Select steel members for use as intermediate supports based on a minimum safety factor of five.
   1. Do not use drive-on beam clamps.
   2. Do not support piping over 4 inches in size from steel bar joists. Secure upper hanger attachments to steel bar joists at panel points of joists.
   3. Do not drill holes in main structural steel members.
   4. Beam clamps, with tie rods as specified, may be used as upper hanger attachments for the support of piping, subject to clamp manufacturer's recommended limits.

C. Attachment to Concrete Filled Steel Decks:
   1. New Construction: Install metal deck ceiling bolts.
   2. Existing Construction: Install welding studs (except at roof decks). Do not support a load in excess of 250 lbs from any single welded stud.
   3. Do not attach hangers to decks less than 2-1/2 inches thick.

D. Attachment to Cast-In-Place Concrete: Secure to overhead construction by means of cast-in-place concrete inserts.

E. Attachment to Existing Cast-In-Place Concrete:
   1. For piping up to a maximum of 4 inches in size, secure hangers to overhead construction with self-drilling type expansion shields and machine bolts.
   2. Secure hangers to wall or floor construction with single unit expansion shields or self-drilling type expansion shields and machine bolts.

F. Attachment to Cored Precast Concrete Decks (Flexicore, Dox Plank, Spancrete, etc.): Toggle bolts may be installed in cells for the support of piping up to a maximum of 2-1/2 inches in size.

G. Attachment to Hollow Block or Hollow Tile Filled Concrete Decks:
   1. New Construction: Omit block or tile and pour solid concrete with cast-in-place inserts.
   2. Existing Construction: Break out block or tile to access, and install machine bolt anchors at highest practical point on side of web.

3.04 ANCHORS, RESTRAINTS, RIGID SUPPORTS, STAYS AND SWAY BRACES

A. Cast Iron Soil Piping Systems:
   1. Where piping is suspended on centers in excess of 18 inches by means of non-rigid hangers, provide sway braces, of design, number and location in accordance with the Cast Iron Soil Pipe Institute's Cast Iron Soil Pipe and Fittings Handbook to prevent horizontal pipe movement.
   2. Additionally, brace piping 5 inches and larger to prevent horizontal movement and/or joint separation. Provide braces, blocks, rodding or other suitable method at each branch opening, or change of direction in accordance with the Cast Iron Soil Pipe Institute's Cast Iron Soil Pipe and Fittings Handbook to prevent horizontal pipe movement.

3.05 PIPING IN TUNNELS

A. Support piping in tunnels on adjustable stanchions, fabricated in accordance with the details on the Drawings, unless otherwise indicated. Install, secure and be responsible for the proper locations of all cast-in-place inserts and stanchion supports, in ample time so as not to delay construction Work. Secure tops of stanchions to overhead construction, as required and approved.

3.06 COMBINATION CLEVIS HANGER, PIPE INSULATION SHIELD AND VAPOR BARRIER JACKETED HIGH DENSITY INSULATING SADDLES

A. Install a combination clevis hanger, pipe insulation shield and vapor barrier jacketed high density insulating saddles, at all points of support for piping or tubing to be insulated for cold service. Furnish companion high density vapor barrier jacketed saddle pieces, of the same material, thickness and length, for installation over the top 180 degree surface of pipe or tubing, at each point of support where an insulated clevis hanger is utilized.

3.07 PIPE INSULATION SHIELDS

A. Unless otherwise specified, install a pipe insulation shield, at all points of support. Center shields on all hangers and supports outside of high density insulation insert, and install in such a manner so as not to cut, or puncture jacket.

3.08 PIPE COVERING PROTECTION SADDLES

A. Install pipe covering protection saddles at all points of support, for steel piping 6 inches in size and larger, insulated with hot service insulation. Weld saddles to piping to insure movement with pipe.

++ END OF SECTION ++

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SECTION 15440

PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Utility sink

1.02 RELATED SECTIONS

A. Joint Sealants: Section 07920.

1.03 SUBMITTALS

A. Product Data: Catalog sheets, specifications, roughing dimensions, and installation instructions for each item specified except fasteners.
   1. Deliver cut out data for countertop fixtures to the Owner's Representative.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with applicable requirements of FS WW-P-541, and the following standards:
      a. ANSI/ASME A112.6.1M - Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
      b. ANSI/ASME A112.18.1M - Plumbing Fixture Fittings.
   2. Each fixture carrier support shall be listed by model number in the fixture support manufacturer's Fixture Support Selection Guide as being recommended for support of the appropriate fixture.
   3. Local and State Building Codes and Ordinances.

B. Plainly and permanently mark each fixture and fitting with the manufacturer's name or trade mark.

C. Acid resistant surfaces shall be plainly and permanently marked with the manufacturer's label or symbol indicating acid resistance.

1.05 MAINTENANCE

A. Special Tools: Deliver to the Owner's Representative.
   1. Furnish the following tools labeled with names and locations where used.
      a. Keys for stops (furnished with stops).
      b. Tools for Vandal Resistant Fasteners: Two for each type and size.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

A. Fixture Trim: Brass, bronze, or stainless steel construction; consisting of supply and waste fittings, faucets, traps, stop valves, escutcheons, sink strainers, nipples, supplies, and metal trim.
   1. Brass piping: Ips standard weight, with standard weight, 125 lb cast brass fittings.
   2. Brass tubing: 18 B & S gage.
   3. Stainless steel: 18-8 Type 302 or 304 unless otherwise specified.

B. Fixture Trim Finishes:
   1. Brass or Bronze: Polished or satin finished chrome plating, 0.02 mil chromium over 0.2 mil nickel plating.
   2. Stainless Steel: Invisible welds and seams, and unless otherwise specified, polished to No. 4 commercial finish.

E. Fixture Hold-down Bolts: Steel, plated for corrosion resistance.
   1. Cap nuts: Metal, polished and chrome plated.

F. For Vandal Resistant Fixtures - Fasteners: Torx head with center pin.

2.02 UTILITY SINK

A. Receptor – Advance Tabco 4-41-24 or approved equal. 16-gauge 430 stainless steel receptor, galvanized tubular legs, adjustable plastic bullet feet.

B. Drain Fitting: Brass p-trap attached to the receptor, ready for connection. Strainer grate shall be stainless steel, removable for cleaning.

C. Service Fitting: Advance Tabco K-105 or approved equal. Combination faucet with 3/4 inch hose end spout, and with the following features.
   1. 1/2 inch eccentric inlets on 8 inch centers and integral stops.
   2. Integral wall flanges.
   3. Renewable units.
   4. Metal, lever, colored indexes.
   5. Integral vacuum breaker.
   6. 14 inch swing spout.

PART 3 EXECUTION

3.01 FIXTURE SUPPORT AND SUPPORTING DEVICE INSTALLATION

A. Fixture Supporting Devices: Attach fixtures by means of the following fixture supporting devices attached to carrier supports.

FIXTURE	SUPPORTING DEVICE
Utility Sink	Drainage fitting and faucet.

B. Secure exposed external components in place with vandal resistant fasteners or devices which cannot be removed without the use of special tools.

3.02 FIXTURE INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions.

B. Install fixtures level and at proper height, tighten connections, and install hold-down bolts, cap nuts and cover plates, where required.

C. Secure exposed external components in place with vandal resistant fasteners or devices which cannot be removed without the use of special tools.

E. Utility Sinks:
   1. Make connection from drainage pipe to receptor drain.
   2. Caulk joints between receptor and wall with Type 1D sealant; strike a neat joint.
   3. Install service fittings.
   4. Score tubing ends before assembling to assure tight slip joint connections. No score marks shall be visible after assembly.
   5. In utility corridors, solder screwed flush pipe connections.

3.03 CLEANING, FLUSHING AND ADJUSTMENT

A. Clean fixture and trim. Remove grease and dirt; polish surfaces but leave stickers and warning labels intact.

B. Flush supply piping and traps; clean strainers.

C. Adjust stops for proper delivery.

++ END OF SECTION ++

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SECTION 15441

EMERGENCY PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Safety stations (combination emergency fixture)

B. Emergency-fixture water-tempering valves

1.02 SUBMITTALS

A. Product Data: Catalog sheets, specifications, roughing dimensions, and installation instructions for each item specified except fasteners.

B. Field Test Reports: Emergency plumbing fixture operational tests.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with applicable requirements of the following standards:
      a. ANSI Z358.1 - Emergency Eyewash & Shower Standard.
      b. ANSI Z535.2 - Facility / Environment Safety Signs.
      c. ASSE 1071 - Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment.
      d. CSA B125.3 - Plumbing Fittings
      e. ADA – Americans with Disabilities Act
   2. Local and State Building Codes and Ordinances.

B. Plainly and permanently mark each fixture and fitting with the manufacturer’s name or trade mark.

C. Acid resistant surfaces shall be plainly and permanently marked with the manufacturer's label or symbol indicating acid resistance.

1.04 MAINTENANCE

A. Special Tools: Deliver to the Owner’s Representative.
   1. Furnish the following tools labeled with names and locations where used:
      a. Tools for Vandal Resistant Fasteners: Two for each type and size.

PART 2 PRODUCTS

2.01 SAFETY STATIONS (COMBINATION EMERGENCY FIXTURE)

A. Combination Eye / Face wash and Shower Safety Station: Guardian GBF1909SSH or approved equal, barrier free, plastic shower head, internal 20 GPM flow control, stainless steel bowl, powder-coated cast aluminum flag handle and floor flange, 1-1/4 inch IPS Schedule 40 galvanized pipe and fittings, 1 inch IPS and 1/2 inch IPS U.S. made chrome-plated brass stay-open ball valves, and polished stainless steel 47-1/2 inch pull rod. (4) Four polypropylene GS-Plus spray heads with integral "flip-top" dust covers, filters, and 1.6 GPM flow control orifices mounted on a chrome-plated brass eyewash assembly. Internally piped waste drain from eye wash to connect to sanitary system.

B. Performance:
   1. Unit shall meet or comply with the following standards:
      a. ANSI Z358.1 - 2014.
      b. ADA compliance.

C. Tepid Supply Water Temperature: Set to 85 degrees F.

D. Water Discharge Flow Rates:
   1. Shower Head: Minimum, 20 gpm at 30 psi for 15 minutes.
   2. Eye wash Spray Heads: Minimum, 0.4 gpm for 15 minutes.

E. Accessories:
   1. Signage: ANSI Z535.2, emergency safety station equipment.
   2. Shut Off Valve: Provide upstream full flow ball valve with detached operating handle.
   3. All valves supplying the emergency stations shall be provided with safety valve lockout with padlock.

2.02 EMERGENCY-FIXTURE WATER-TEMPERING VALVES

A. Emergency Thermostatic Mixing Valve: Haws 9202E or approved equal. Designed to provide 85 deg. F. tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg. F. throughout required 15-minute test period, and in case of unit failure to continue tepid flow, cold water would continue through cold water bypass.

B. Performance:
   1. Unit shall meet or comply with the following standards:
      a. ASSE 1071.
      a. ANSI Z358.1 - 2014.
      b. Applicable sections of CSA B125.3.

C. Tepid Water Supply Temperature: Set to 85 degrees F.

D. Capacity: Provides 1 to 78 gpm at 30 psi supply pressure.

E. Valve Assembly: Thermostatic mixing (blending) type made of lead-free cast brass body with integral built-in cold water bypass (fail safe), color marked dual-scale outlet temperature gauge, integral inlet check valve, integral inlet strainer, locking-type regulator, and mounting bracket.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that fixtures and accessories are of the correct type and size prior to installation.

B. Verify that deck, wall and floor finishes are prepared and ready for fixture installation.

C. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EMERGENCY FIXTURE INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions.

B. Install fixtures level and at proper height, tighten connections, and install hold-down bolts, cap nuts and cover plates, where required.

C. Secure exposed external components in place with vandal resistant fasteners or devices which cannot be removed without the use of special tools.

D. Adjust water flow rates to comply with manufacturer's rating of the fixture.

E. Place remote-activated thermostatically actuated bleed valve behind wall or buried below frost line.

F. Safety Stations (Combination Emergency Fixture)
   1. Bolt universal floor flange to finished floor with vandal resistant fasteners.

3.03 CLEANING

A. Clean fixture and trim. Remove grease and dirt; polish surfaces but leave stickers and warning labels intact.

B. Flush supply piping and traps; clean strainers.

3.04 PROTECTION

A. Protect installed products from damage due to subsequent construction operations.

B. Repair or replace products damaged before Date of Substantial Completion.

3.05 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspections reports.

++ END OF SECTION ++

SECTION 15455

DOMESTIC HOT WATER STORAGE TANKS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hot water storage tanks

1.02 RELATED SECTIONS

A. Valves for Plumbing Systems: Section 15400.

B. Electric Work: Division 16.

1.03 SUBMITTALS

A. Product Data: Catalog sheets, specifications and installation instructions for each water heater.

B. Contract Closeout Submittals:
   1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Owner's Representative.
   2. Warranty: Copy of specified warranty.

1.04 REGULATORY REQUIREMENTS

A. Storage tank shall be UL listed and labeled.

B. Comply with the State Energy Conservation Construction Code.

1.05 WARRANTY

A. Manufacturer's Warranty: Three year warranty for the glass lined water heater tank.

PART 2 PRODUCTS

2.01 HOT WATER STORAGE TANK

A. Tank: Welded steel, factory tested at 300 psi and rated for 150 psi working pressure.
   1. Glass lining permanently bonded to tank interior surface.
   2. Tank nipples factory installed.
   3. Renewable magnesium anode.
   4. Corrosion resistant dip tube.
   5. Drain and relief valve tapping.

6. Renewable bronze boiler drain.

B. Outer Casing: Steel, with baked enamel or acrylic finish.

C. Pressure-Temperature Relief Valve: AGA Z21.22; bronze body with stainless steel internals and threaded blow-off connection.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.

B. Install the storage tank on a level, firm base.

C. Install the pressure-temperature relief valve in the dedicated tank tapping. Pipe the relief valve blow-off to a point 6 inches above the floor.

D. Provide ball valves on hot and cold water connections.

E. Make final piping connections with unions.

F. Flush and fill tank.

++ END OF SECTION ++

SECTION 15497

CLEANING AND TESTING FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cleaning and testing equipment and media

1.02 SUBMITTALS

A. Quality Control Submittals
   1. Test Reports (Field Tests): Submit data for each system tested, and/or disinfected; include date performed, description, and test results for each system.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Perform factory testing of factory fabricated equipment in complete accordance with the agencies having jurisdiction.
   2. Perform field testing of piping systems in complete accordance with the local utilities and other agencies having jurisdiction and as specified.
   3. Local and State Building Codes and Ordinances.

1.04 PROJECT CONDITIONS

A. Protection: During test Work, protect controls, gages and accessories which are not designed to withstand test pressures. Do not utilize permanently installed gages for field testing of systems.

1.05 SEQUENCING AND SCHEDULING

A. Transmit written notification of proposed date and time of operational tests to the Owner's Representative at least 5 days in advance of such tests.

B. Perform cleaning and testing Work in the presence of the Owner's Representative.

C. Pressure test piping systems inside buildings, at the roughing-in stage of installation, before piping is enclosed by construction Work, and at other times as directed. Perform test operations in sections as required and directed, to progress the Work in a satisfactory manner and not delay the general construction of the building. Valve or cap-off sections of piping to be tested, utilizing valves required to be installed in the permanent piping systems, or temporary valves or caps as required to perform the Work.

PART 2 PRODUCTS

2.01 CLEANING AND TESTING EQUIPMENT AND MEDIA

A. Test Equipment and Instruments: Type and kind as required for the particular system under test.

B. Test Media (air, vacuum, water): As specified for the particular piping or system under test.

C. Cleaning Agent (water): As specified for the particular piping, apparatus or system being cleaned.

PART 3 EXECUTION

3.01 PRELIMINARY WORK

A. Thoroughly clean pipe and tubing prior to installation. During installation, prevent foreign matter from entering systems. Prevent if possible and remove stoppages or obstructions from piping and systems.

3.02 PRESSURE TESTS - PIPING

A. Piping shall be tight under test and shall not show loss in pressure or visible leaks, during test operations or after the minimum duration of time as specified. Remove piping which is not tight under test; remake joints and repeat test until no leaks occur.

B. Water Systems:
   1. Domestic water (potable cold, domestic hot and recirculation) inside buildings:
      a. Before fixtures, faucets, trim and accessories are connected, perform hydrostatic test at 125 psig minimum for 4 hours.
      b. After fixtures, faucets, trim and accessories are connected, perform hydrostatic retest at 75 psig for 4 hours.

C. Drainage, Vent, Conductor and Roof Drain Piping (Inside Buildings): Perform tests before fixtures are installed. Test by filling the entire system with water, and allowing to stand for 3 hours, with no noticeable loss of water. Test joints under a minimum head of 10 feet of water, except the uppermost section. Test the uppermost section to overflowing.

3.03 TESTING OF EQUIPMENT, APPARATUS AND APPURTENANCES

A. Relief Valves: Increase pressure in equipment or apparatus to relief valve setting, to test opening of valves at required relief pressures.

3.04 DISINFECTION OF POTABLE WATER SYSTEMS

A. Disinfect potable water pipe and equipment installed in the Work of this Contract.

1. Completely fill the piping, including water storage equipment if installed, with a water solution containing 50 mg/L available chlorine, and allow stand for 24 hours. Operate all valves during this period to assure their proper disinfection.
2. After the retention period, discharge the solution to an approved waste and flush the system thoroughly with water until substantially all traces of chlorine are removed. Drain and flush water storage equipment if installed.

B. Connect plumbing fixtures and equipment and place the system into service. Prevent recontamination of the piping during this phase of the Work.

++ END OF SECTION ++

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SECTION 15620

WATER-TO-WATER HEAT PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Indoor water-to-water heat pumps utilizing a water loop as the source and with a second independent heated water loop as the output load.

1.02 RELATED SECTIONS

A. Section 15180 - Pipe, Valves, and Fittings for HVAC Systems

B. Section 15182 - Thermometers and Pressure Gauges for HVAC Systems

C. Section 15183 - Hydronic Specialties for HVAC Systems

D. Section 15184 - Piping Specialties for HVAC Systems

E. Section 15940 - Sequence of Operations for HVAC Systems

F. Division 16 – Electrical Work

1.03 SUBMITTALS

A. Shop Drawings: Submit drawings for each unit.

B. Product Data: Manufacturer's catalog sheets, brochures, performance charts, schematic drawings, specifications and installation instructions for each unit.

C. Contract Closeout Submittals - Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Owner.

1.04 QUALITY ASSURANCE

A. The water-to-water heat pump units shall be ETL listed in accordance with UL Standard 60335-2-40.

B. Heat exchanger shall be designed, tested, and stamped in accordance with UL 1995 code for 650 psig working pressure on the evaporator and 650 psig working pressure on the condenser.

C. All units shall be factory run tested prior to shipment.

1.05 PRODUCT DELIVERY

A. Unit shall be stored and handled per manufacturer's recommendations.

1.06 WARRANTY

A. Contractor shall ensure that all units are registered with the manufacturer to ensure all warranties are in place after unit installation.

B. Manufacturer shall provide full parts warranty coverage for entire heat pump unit for a period of one year from startup or 15 months from date of shipment, whichever is less. All parts shall be warranted against defects in material and workmanship.

PART 2 - PRODUCTS

2.01 GENERAL

A. GENERAL
   1. Acceptable Manufacturer's include:
      a. Chillmaster
      b. Quantech
      c. Tandem
      d. York
   2. Shall be designed to operate using R-454b or R-513a Refrigerant.
   3. The liquid to be heated/chilled will be water containing corrosion inhibitors.
   4. Performance and electrical requirements shall be as called for on the HVAC Schedules.
   5. Units shall ship wired and charged with refrigerant.

2.02 WATER-TO-WATER HEAT PUMPS (10-TON)

A. Casing
   1. The unit shall be built with heavy gauge steel frame.
   2. Each unit shall include supply and return connections for both chilled and hot water.
   3. Water header shall be readily accessible from the back of the system.
   4. Casing shall include a removable electrical enclosure for easy maintenance and access to compressors without removal of system connections.

B. Evaporators and Condensers
   1. Each evaporator and condenser shall be brazed plate heat exchangers constructed of 316 stainless steel and copper brazing; designed, tested, and stamped for 650 psig working pressure on the evaporator and 650 psig working pressure on the condenser.

C. Compressor
   1. Shall incorporate scroll compressors and can consist of multiple (10 or 15) -ton modules. Each unit shall consist of one compressor, each compressor with its own

refrigeration circuit. Each refrigerant circuit shall consist of a hermetically sealed scroll compressor, water to refrigerant condenser, water to refrigerant evaporator, electronically controlled thermal expansion valves, sight-glasses, and control system. Each circuit's refrigerant and electrical systems shall be independent of other circuits. They shall have the capability of running in in the event of another circuit failing.

2. Each unit shall contain one independent hermetic scroll compressor with built-in safeties to ensure optimal operation. Each compressor shall have its own crankcase heater to keep oil hot increase compressor life.

D. Refrigerant
   1. Refrigerant lines shall include refrigerant service ports that are readily accessible for maintenance readings and refrigerant charging without disconnecting the unit from other connected systems.
   2. Refrigerant service ports shall have built-in Schrader valves to be accessed without being required to pull a vacuum on the system.

E. Controller
   1. The system shall be equipped with an advanced OS based controller with built in operating system, internal memory, processor, and user interface. The system shall have the ability to operate as a standalone system or in tandem with other connected Systems. The system shall have the ability to recognize the addition of new connected Modules and adjust its settings without reprogramming. The system shall have the capability to operate in response to either heating water or cooling water set points. The system will have the ability to activate based on a 24V external analog customer signal.
   2. Activation of the connected modules and compressors will be determined by the selected Client System. All other modules will be selected to operate as Server Systems.
   3. Compressors will rotate start position to ensure even runtime both within an individual module and within total connected system.
   4. Each Module shall monitor and report the following: System Status, Leaving Hot Water Temperature, Leaving Cold Water Temperature, Discharge Pressure, Suction Pressure, Suction Temperature, Super Heat, Compressor Run Hours, and Current Leadlag Position.
   5. The Client System shall monitor and report the following for each connected system: System Status, Entering Hot Water Temperature, Leaving Hot Water Temperature, Entering Cold Water Temperature, Leaving Cold Water Temperature, Discharge Pressure, Suction Pressure, Suction Temperature, Compressor Run Hours, and Current Leadlag Position.
   6. The Client System shall have shared power with the number one heat pump module and shall monitor chill water and hot water flow, chill water and hot water pump auxiliaries, customer interlock, client entering and leaving hot water temperature, client entering and leaving cold water temperature, client cold water and hot water setpoints, and total system run percentage.

7. Each system shall include all necessary safety faults and alarms to protect the system from dangerous run conditions. In the event of a fault, the system will shut down necessary refrigeration circuits and display the type of alarm. The system will remain locked out for faults that require maintenance attention or reset itself for temporary or minor faults.
8. The Client System will monitor and report major faults and will lock out connected systems accordingly.
9. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed with freezestat faults to protect against freezing water in the evaporator and water lines.
10. The control system shall monitor entering and leaving hot and chilled water temperatures to determine the number of compressors required to operate. Response times and set points shall be adjustable. The system shall have adjustable time delays between compressor starts and temperature sensing, to optimize the system performance.
11. Each system shall have the ability to run as a manually selectable “Service Mode” in the event of a Client System or controller failure.
12. The system shall have the ability to send 24V enable/disable signals to external systems such as third party chillers and boilers. The system will have the ability to run in conjunction and automatically activate external systems in the event of power loss or inadequate water output temperature.
13. The system shall have the ability to automatically adjust its water setpoints and run conditions based on selectable ambient air temperatures.
14. The system shall have the ability to adjust all connected systems run conditions using a single, selectable master water temperature setpoint.
15. The system shall have the ability to send a 24V fault indicator signal.
16. The system shall have the ability to run alongside 9 other connected systems.
17. The system shall have the ability to internally log certain data points saved in Microsoft Excel format and may be exported to a standard USB flashdrive with no technical expertise.
18. System shall have a single point power connection and external inputs and outputs. Inputs/Outputs include:
    a. Customer Interlock (Remote start/stop)
    b. Major Fault Relay
    c. External System 1 Relay (enable/disable)
    d. External System 2 Relay (enable/disable)
    e. Power Phase Monitor
    f. Hot Water Flow Switch Input
    g. Condenser Water Flow Switch Input
    h. Hot Water Pump Relay
    i. Condenser Water Pump Relay
    j. Hot Water Pump Auxiliary Input
    k. Condenser Water Pump Auxiliary Input
19. System shall have low and high voltage wiring separated and readily accessible from a single location on the system.

20. System status display shall be mounted on the outside of the low voltage panel on a Standalone or Client System.
21. System shall include individual LED compressor run indicator lights on the front of the low voltage panel to indicate run condition of compressor circuits.

F. Safeties, Controls, and Operation
   1. System safety controls system shall be provided with the unit (minimum) as follows:
      a. Low suction refrigerant pressure
      b. High discharge refrigerant pressure
      c. Low leaving water temperature
      d. Motor protector
      e. Loss of charge
      f. Phase monitor
      g. Loss of communication
   2. Any faults that occur will display on the controller screen. The faults shall be displayed in plain English without the use of alphanumeric codes.
   3. Normal System Operation
      a. The system shall automatically determine the minimum necessary number of compressors required to run to reach the desired setpoint value.
      b. The system shall respond to the difference between the supply temperature (or tank probe) setpoint and the entering water temperature using PD control.
   4. Power Phase Monitor
      a. The system shall include a power phase monitor to keep the system from operating in poor power conditions.
      b. The power phase monitor shall provide protection against the following conditions:
         1) Low Voltage
         2) Phase Rotation
         3) Loss of Phase
         4) Phase Imbalance

G. Options and Accessories
   1. Additional options and accessories shall be as called for on the HVAC Schedules.

2.03 WATER-TO-WATER HEAT PUMPS (30-TON)

A. Casing
   1. The unit shall be built with heavy gauge steel frame.
   2. Each unit shall include supply and return connections for both chilled and hot water.
   3. Water header shall be readily accessible from the back of the system.
   4. Casing shall include a removable electrical enclosure for easy maintenance and access to compressors without removal of system connections.

B. Evaporators and Condensers

1. Each evaporator and condenser shall be brazed plate heat exchangers constructed of 316 stainless steel and copper brazing; designed, tested, and stamped for 650 psig working pressure on the evaporator and 650 psig working pressure on the condenser.

C. Compressor
   1. System shall incorporate scroll compressors and can consist of multiple (20, 30, 40, 50, 70, or 80) -ton modules. Each unit shall consist of two compressors, each compressor with its own refrigeration circuit. Each refrigerant circuit shall consist of a hermetically sealed scroll compressor, water to refrigerant condenser, water to refrigerant evaporator, electronically controlled thermal expansion valves, sight-glasses, and control system. Each circuit's refrigerant and electrical systems shall be independent of other circuits. They shall have the capability of running in in the event of another circuit failing.
   2. Each unit shall contain two independent hermetic scroll compressors with built-in safeties to ensure optimal operation. Each compressor shall have its own crankcase heater to keep oil hot increase compressor life.

D. Refrigerant
   1. Refrigerant lines shall include refrigerant service ports that are readily accessible for maintenance readings and refrigerant charging without disconnecting the unit from other connected systems.
   2. Refrigerant service ports shall have built-in Schrader valves to be accessed without being required to pull a vacuum on the system.

E. Controller
   1. The system shall be equipped with an advanced OS based controller with built in operating system, internal memory, processor, and user interface. The system shall have the ability to operate as a standalone system or in tandem with other connected systems. The system shall have the ability to recognize the addition of new connected Modules and adjust its settings without reprogramming. The system shall have the capability to operate in response to either heating water or cooling water set points. The system will have the ability to activate based on a 24V external analog customer signal.
   2. Activation of the connected modules and compressors will be determined by the selected Client System. All other modules will be selected to operate as Server Systems.
   3. Compressors will rotate start position to ensure even runtime both within an individual Chillmaster module and within total connected Chillmaster system.
   4. Each Module shall monitor and report the following: System Status, Leaving Hot Water Temperature, Leaving Cold Water Temperature, Discharge Pressure, Suction Pressure, Suction Temperature, Super Heat, Compressor Run Hours, and Current Leadlag Position.
   5. The Client System shall monitor and report the following for each connected system: System Status, Entering Hot Water Temperature, Leaving Hot Water Temperature, Entering Cold Water Temperature, Leaving Cold Water

Temperature, Discharge Pressure, Suction Pressure, Suction Temperature, Compressor Run Hours, and Current Leadlag Position.

6. The Client System shall have shared power with the number one heat pump module and shall monitor chill water and hot water flow, chill water and hot water pump auxiliaries, customer interlock, client entering and leaving hot water temperature, client entering and leaving cold water temperature, client cold water and hot water setpoints, and total system run percentage.
7. Each system shall include all necessary safety faults and alarms to protect the system from dangerous run conditions. In the event of a fault, the system will shut down necessary refrigeration circuits and display the type of alarm. The system will remain locked out for faults that require maintenance attention or reset itself for temporary or minor faults.
8. The Client System will monitor and report major faults and will lock out connected systems accordingly.
9. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed with freezestat faults to protect against freezing water in the evaporator and water lines.
10. The control system shall monitor entering and leaving hot and chilled water temperatures to determine the number of compressors required to operate. Response times and set points shall be adjustable. The system shall have adjustable time delays between compressor starts and temperature sensing, to optimize the Chillmaster System performance.
11. Each system shall have the ability to run as a manually selectable “Service Mode” in the event of a Client System or controller failure.
12. The system shall have the ability to send 24V enable/disable signals to external systems such as third party chillers and boilers. The system will have the ability to run in conjunction and automatically activate external systems in the event of power loss or inadequate water output temperature.
13. The system shall have the ability to automatically adjust its water setpoints and run conditions based on selectable ambient air temperatures.
14. The system shall have the ability to adjust all connected systems run conditions using a single, selectable master water temperature setpoint.
15. The system shall have the ability to send a 24V fault indicator signal.
16. The system shall have the ability to run alongside 9 other connected Chillmaster systems.
17. The system shall have the ability to internally log certain data points saved in Microsoft Excel format and may be exported to a standard USB flashdrive with no technical expertise.
18. System shall have a single point power connection and external inputs and outputs. Inputs/Outputs include:
    a. Customer Interlock (Remote start/stop)
    b. Major Fault Relay
    c. External System 1 Relay (enable/disable)
    d. External System 2 Relay (enable/disable)
    e. Power Phase Monitor
    f. Hot Water Flow Switch Input

g. Condenser Water Flow Switch Input
h. Hot Water Pump Relay
i. Condenser Water Pump Relay
j. Hot Water Pump Auxiliary Input
k. Condenser Water Pump Auxiliary Input

19. System shall have low and high voltage wiring separated and readily accessible from a single location on the system.
20. System status display shall be mounted on the outside of the low voltage panel on a Standalone or Client System.
21. System shall include individual LED compressor run indicator lights on the front of the low voltage panel to indicate run condition of compressor circuits.

F. Safeties, Controls, and Operation
1. System safety controls system shall be provided with the unit (minimum) as follows:
a. Low suction refrigerant pressure
b. High discharge refrigerant pressure
c. Low leaving water temperature
d. Motor protector
e. Loss of charge
f. Phase monitor
g. Loss of communication
2. Any faults that occur will display on the controller screen. The faults shall be displayed in plain English without the use of alphanumeric codes.
3. Normal System Operation
a. The system shall automatically determine the minimum necessary number of compressors required to run to reach the desired setpoint value.
b. The system shall respond to the difference between the supply temperature (or tank probe) setpoint and the entering water temperature using PD control.
4. Power Phase Monitor
a. The system shall include a power phase monitor to keep the system from operating in poor power conditions.
b. The power phase monitor shall provide protection against the following conditions:
1) Low Voltage
2) Phase Rotation
3) Loss of Phase
4) Phase Imbalance

G. Options and Accessories
1. Additional options and accessories shall be as called for on the HVAC Schedules.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install unit on structural steel or concrete pad as shown on the Drawings. Install unit in accordance with manufacturer's instructions.

B. Flush the piping sytem to remove any sediment prior to connecting the piping to the unit. The piping system shall be able to be flushed for six (6) hours without any residue or buildup in the strainer before it is acceptable to connect the piping to the unit. Replace temporary strainer screen with new screen at completion of flushing prior to unit startup.

C. Provide water treatment as called for on the Drawings.

3.02 FIELD QUALITY CONTROL

A. The unit manufacturer shall provide complete start-up supervision by a certified technician with on-site owner training. Training shall include basic system overview, operation, and troubleshooting.

+ + END OF SECTION + +

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SECTION 15640

AIR-TO-WATER HEAT PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Outdoor air-to-water heat pump units utilizing ambient air as the source/sink and with heated/cooled water as the output load.

1.02 RELATED SECTIONS

A. Section 15180 - Pipe, Valves, and Fittings for HVAC Systems

B. Section 15182 - Thermometers and Pressure Gauges for HVAC Systems

C. Section 15183 - Hydronic Specialties for HVAC Systems

D. Section 15184 - Piping Specialties for HVAC Systems

E. Section 15940 - Sequence of Operations for HVAC Systems

F. Division 16 – Electrical Work

1.03 SUBMITTALS

A. Shop Drawings: Submit drawings for each unit.

B. Product Data: Manufacturer's catalog sheets, brochures, performance charts, schematic drawings, specifications and installation instructions for each unit.

C. Contract Closeout Submittals - Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Owner.

1.04 QUALITY ASSURANCE

A. The air-to-water heat pump units shall be ETL listed in accordance with UL Standard 60335-2-40.

B. Heat exchanger shall be designed, tested, and stamped in accordance with UL 1995 code for 650 psig working pressure on the evaporator and 650 psig working pressure on the condenser.

C. All models shall be factory run tested prior to shipment.

1.05 PRODUCT DELIVERY

A. Unit shall be stored and handled per manufacturer's recommendations.

1.06 WARRANTY

A. Contractor shall ensure that all units are registered with the manufacturer to ensure all warranties are in place after unit installation.

B. Manufacturer shall provide full parts warranty coverage for entire heat pump unit for a period of one year from startup or 15 months from date of shipment, whichever is less. All parts shall be warranted against defects in material and workmanship.

PART 2 - PRODUCTS

2.01 AIR-TO-WATER HEAT PUMP UNITS

A. General
   1. Acceptable Manufacturer's include:
      a. Chillmaster
      b. Quantech
      c. Jetson
      d. York
   2. Units shall have the capability to operate in cooling mode in ambient temperatures up to 120°F and operate in heating mode in ambient temperatures down to -10°F.
   3. Units shall utilize R-454B refrigerant. System shall be factory charged with refrigerant.
   4. Performance and electrical requirements shall be as called for on the HVAC Schedules.

B. Casing
   1. The unit shall be built with heavy gauge steel frame.
   2. Unit shall have supply and return water connections.
   3. Water header shall be readily accessible.

C. Refrigeration Circuits
   1. Unit shall consist of two isolated refrigeration circuits.
   2. Each refrigerant circuit shall consist of a hermetically sealed scroll compressor, water to refrigerant heat exchanger, sight-glasses, and control system.
   3. Water heat exchangers shall be brazed plate heat exchangers constructed of 316 stainless steel and copper brazing; designed, tested, and stamped in accordance with UL 1995 code for 650 psig working pressure on the evaporator and 650 psig working pressure on the condenser.
   4. Air heat exchanger shall be an air-to-refrigerant coil with copper tubes and aluminum fins.
   5. Isolation valves shall be installed between the heat exchangers and water supply mains for heat exchanger isolation and removal without the requirement to shut down the entire heat pump system.

6. Each refrigeration circuit shall contain a hermetic scroll compressor with built-in safeties to ensure optimal operation. Each compressor shall have its own crankcase heater to keep oil hot and increase compressor life.
7. Refrigerant lines shall include refrigerant service ports that are readily accessible for maintenance readings and refrigerant charging.
8. Refrigerant service ports shall have built-in Schrader valves to be accessed without being required to pull a vacuum on the system.

D. Controls
1. The system shall be equipped with an advanced OS based controller with built in operating system, internal memory, processor, and user interface. The system shall have the ability to operate as a standalone system or in tandem with other connected systems of the same manufacturer. The system shall have the capability to operate in response to either heating water or cooling water set points. The system shall have the ability to activate based on a 24V external analog customer signal.
2. Compressors shall rotate start position to ensure even runtime within total connected system.
3. The system shall monitor and report the following: System Status, Entering Water Temperature, Leaving Water Temperature, Discharge Pressure, Suction Pressure, Suction Temperature, Super Heat, and Compressor Run Hours.
4. The system shall be powered by a single point power connection and shall monitor chill water and hot water flow, chill water and hot water pump auxiliaries, customer interlock, client entering and leaving cold water temperature, client cold water and hot water setpoints, and total system run percentage.
5. Each system shall include all necessary safety faults and alarms to protect the system from dangerous run conditions. In the event of a fault, the system shall shut down necessary refrigeration circuits and display the type of alarm. The system shall remain locked out for faults that require maintenance attention or reset itself for temporary or minor faults.
6. The controller shall monitor and report major faults and shall lock out connected devices accordingly.
7. Individual monitoring of leaving water temperatures from each refrigeration system shall be programmed with freezestat faults to protect against freezing water in the heat exchanger.
8. The control system shall monitor entering and leaving water temperatures to determine the number of compressors required to operate. Response times and set points shall be adjustable. The system shall have adjustable time delays between compressor starts and temperature sensing, to optimize system performance.
9. Each unit shall have the ability to run as a manually selectable system in the event of a controller failure.
10. The system shall have the ability to automatically adjust its water setpoints and run conditions based on selectable ambient air temperatures.
11. The system shall have the ability to adjust all connected run conditions using a single, selectable master water temperature setpoint.
12. The system shall have the ability to send a 24V fault indicator signal.

13. The system shall have the ability to internally log certain data points saved in Microsoft Excel format and may be exported to a standard USB flashdrive with no technical expertise.
14. The system shall have a single point power connection and external inputs and outputs. Inputs/Outputs include:
    a. Customer Interlock (Remote start/stop)
    b. Fault Indicator Relay
    c. Power Phase Monitor
    d. Pump Relay
    e. Flow Switch Input
15. System status display shall be mounted on the outside of the low voltage panel.
16. The system shall include individual LED compressor run indicator lights on the front of the low voltage panel to indicate run condition of compressor circuits.

E. Safeties, Controls, and Operation
    1. Safety controls system shall be provided with the unit (minimum) as follows:
        a. Low suction refrigerant pressure
        b. High discharge refrigerant pressure
        c. Low leaving water temperature
        d. Motor protector
        e. Loss of charge
        f. Phase monitor
        g. Loss of communication
    2. Any faults that occur will display on the controller screen. The faults shall be displayed in plain English without the use of alphanumeric codes.
    3. Normal System Operation
        a. The system shall automatically determine the minimum necessary number of compressors required to run to reach the desired setpoint value.
    4. Power Phase Monitor
        a. The system shall include a power phase monitor to keep the system from operating in poor power conditions.
        b. The power phase monitor shall provide protection against the following conditions:
            1) Low Voltage
            2) Phase Rotation
            3) Loss of Phase
            4) Phase Imbalance

F. Options and Accessories
    1. Additional options and accessories shall be as called for on the HVAC Schedules.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install unit on structural steel or concrete pad as shown on the Drawings. Install unit in accordance with manufacturer's instructions.

B. Flush the piping system to remove any sediment prior to connecting the piping to the unit. The piping system shall be able to be flushed for six (6) hours without any residue or buildup in the strainer before it is acceptable to connect the piping to the unit. Replace temporary strainer screen with new screen at completion of flushing prior to unit startup.

C. Provide water treatment as called for on the Drawings.

3.02 FIELD QUALITY CONTROL

A. The unit manufacturer shall provide complete start-up supervision by a certified technician with on-site owner training. Training shall include basic system overview, operation, and troubleshooting.

+ + END OF SECTION + +

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SECTION 15737

ELECTRICAL ROOM AIR CONDITIONERS

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTION

A. The systems shall consist of an indoor evaporator unit with variable speed fan(s) and variable speed compressor(s), an outdoor condenser with variable speed fan(s), refrigerant economizer module, and controls.

1.02 QUALITY ASSURANCE

A. Units shall be CSA-certified to CSA C22.2 No 236/UL 1995 for Heating and Cooling Equipment and marked with the CSA c-us logo.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. Units shall be AHRI certified using AHRI Standard 1360.

D. The system shall be factory tested before shipment. The manufacturer shall be ISO 9001 certified.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

1.04 WARRANTY

A. Contractor shall ensure that all units are registered with the manufacturer to ensure all warranties are in place after installation.

B. Parts shall be warranted for a period of one (1) year from date of installation.

C. Compressors shall be warranted for an additional period of (6) years after the end of the standard parts warranty.

1.05 SUBMITTALS

A. Submit manufacturer's product data including capacity of unit, electrical requirements, airflow, sound pressure data, indoor and outdoor unit measurements, weight, control schematics, dimensioned drawings, and wiring diagrams.

PART 2 - PRODUCTS

2.01 GENERAL

A. Equipment performance requirements and electrical requirements shall be as called for on the equipment schedules.

B. The manufacturer shall size all refrigerant piping and shall provide shop drawing indicating layout of refrigerant piping for each system.

C. The system shall be designed to control temperature and humidity conditions in rooms containing electronic equipment.

D. Acceptable manufacturers, subject to submittal review, include:
   1. Vertiv
   2. Schneider Electric
   3. Stulz

2.02 INDOOR UNIT AIR CONDITIONERS (ERAC)

A. Frame
   1. The frame shall be welded, formed sheet metal. It shall be protected against corrosion using the autophoretic coating process. The frame shall be capable of being separated into three parts in the field to accommodate rigging through small spaces.
   2. The supply air shall exit from the top of the unit.
   3. The return air shall enter the unit from the front of the cabinet through factory-installed grilles. Grilles shall be painted black.
   4. The exterior panels shall be insulated with a minimum 1 in. (25 mm), 1.5 lb. (0.68 kg) density fiber insulation. The main front panel shall have captive quarter-turn fasteners. The main unit color shall be Black Gray Matte.
   5. The cabinet shall be designed so that all components are easily accessible for service and maintenance through the front of the unit.

B. Filters
   1. The filter chamber shall be located within the cabinet, and filters shall be removable from the front of the unit.
   2. Filters shall be deep-pleated, 4 in. (102 mm) filters with an ASHRAE 52.2-2007 MERV8 or MERV11 rating.
   3. An extra set(s) of filters shall be provided per system.

C. Locking Disconnect Switch
   1. The manual disconnect switch shall be mounted in the high voltage section of the electrical panel. The switch shall be accessible from the outside of the unit with the door closed and shall prevent access to the high voltage electrical components until switched to the OFF position.

D. Short Circuit Current Rating (SCCR)

1. The electrical panel shall provide at least 65,000A SCCR (60 Hz).
2. Short circuit current rating (SCCR) is the maximum short-circuit current a component or assembly can safely withstand when protected by a specific overcurrent protective device(s) or for a specified time.

E. Fan Section
1. The fans shall be plug/plenum type, motorized impellers, single inlet and dynamically balanced. The drive package shall be direct drive, electronically commutated (EC) and variable speed.

F. Refrigeration System
1. Each unit shall include two (2) independent refrigeration circuits and each circuit shall include liquid line filter driers, refrigerant sight glass with moisture indicator and electronic expansion valves. Compressors shall be located outside the air stream and shall be removable and serviceable from the front of the unit. Each compressor circuit shall be connected to the full-face area of the evaporator coil.

G. Air Cooled Systems
1. The indoor evaporator unit shall include refrigerant piping and shall have a factory holding charge of nitrogen. The hot-gas and liquid lines shall be spun shut and each shall include a factory-installed Schrader valve. Field-relief of the Schrader valve shall indicate a leak-free system from the factory. Installing contractor shall cut the evaporator piping and shall evacuate and charge the system. Refrigerant shall be supplied by the installing contractor.

H. Compressors
1. The compressors shall be digital scroll-type with a variable capacity operation capability. Compressor solenoid valve shall unload the compressor and allow for variable capacity operation. The compressor shall have vibration isolators, thermal overloads, automatic reset high-pressure switch with lockout after three failures, rotalock service valves, suction line strainer and a maximum operating speed of 3500 rpm. The compressor motor shall be suction gas cooled.
2. The compressors shall include crankcase heaters, powered from the indoor unit electric panel.

I. Evaporator Coil
1. The evaporator coil shall be V-frame design. It shall be constructed of rifled copper tubes and aluminum fins. A stainless-steel condensate drain pan shall be provided.

J. R-410A Refrigerant
1. The system shall be designed for use with R-410A refrigerant. Refrigerant shall be field supplied, and field charged by the installing contractor.

2.03 OUTDOOR UNIT CONDENSERS (CU)

A. Summary

1. The condenser shall be designed to reject waste heat to outdoor air and to control refrigerant head pressure as indoor equipment loading and outdoor ambient conditions change.
2. The manufacturer shall design and furnish all equipment in the quantities and configurations shown on the project drawings.
3. The air-cooled condenser shall be a factory-assembled unit, complete with integral electrical panel, designed for outdoor installation. The condenser shall be a draw-through design.
4. Condenser shall consist of microchannel condenser coil(s), propeller fan(s) direct driven by individual fan motor(s), electrical controls, housing and mounting legs. The air-cooled condenser shall provide positive refrigerant head pressure control to the indoor cooling unit by adjusting heat rejection capacity. Microchannel coils shall provide superior heat transfer, reduce air-side pressure drop, increase energy efficiency and significantly reduce the system refrigerant volume required. EC fans and fan operating techniques shall reduce sound levels.

B. Coil
1. Coils shall be constructed of aluminum microchannel tubes, fins and manifolds. Tubes shall be flat and contain multiple, parallel flow microchannels and span between aluminum headers. Full-depth louvered aluminum fins shall fill spaces between the tubes. Tubes, fins and aluminum headers shall be oven-brazed to form a complete refrigerant-to-air heat exchanger coil. Copper stub pipes shall be electric resistance-welded to aluminum coils and joints protected with polyolefin to seal joints from corrosive environmental elements. Coil assemblies shall be factory leak tested at a minimum of 300 psig (2068 kPag). Hot-gas and liquid lines shall be copper and shall be brazed using nitrogen gas flow to the stub pipes with spun-closed ends for customer piping connections. Complete coil/piping assembly shall be then filled and sealed with an inert gas holding charge for shipment.
2. Aluminum microchannel coil with E-coat shall be epoxy-coated. Factory-applied E-coat using immersion and baking process shall provide a flexible epoxy-coating to all coil surfaces. Coil color shall be black and shall be protected from solar UV ray degradation with a factory-applied UV topcoat. E-coat shall increase coil corrosion protection and shall reduce heat rejection capacity degradation to less than 10% after a severe 2000 hour 5% neutral salt spray test (ref. ASTM B117). The coating process shall ensure complete coil encapsulation.

C. Fan Motor/Blade Assembly
1. The fan motor/blade assembly shall have an external rotor motor, fan blades and fan/finger guard. Fan blades shall be constructed of cast aluminum or glass-reinforced polymeric material. Fan guards shall be heavy gauge, close-meshed steel wire, coated with a black, corrosion-resistant finish. Fan terminal blocks shall be in an IP54 enclosure on the top of the fan motor. Fan assemblies shall be factory-balanced, tested before shipment, and mounted securely to the condenser structure.
2. The EC-fan motors shall be electronically commutated for variable-speed operation and shall have ball bearings. The EC fans shall provide internal overload protection through built-in electronics. Each EC- fan motor shall have a built-in

controller and communication module linked via RS485 communication wire to each fan and the Premium Control Board, allowing each fan to receive and respond to precise fan speed inputs from the Premium Control Board.

D. Electrical Controls
   1. Electrical controls and service-connection terminals shall be provided and factory-wired inside the attached control panel section. Only high voltage supply wiring and low voltage indoor-unit communication/interlock wiring are required at condenser installation.
   2. EC Fan Control System shall include an electronic control board, EC fan motor(s) with internal overload protection, refrigerant and ambient temperature thermistors and refrigerant pressure transducers. The Control Board shall communicate directly with the indoor unit's control via field supplied CANbus communication wires and via field- supplied low voltage interlock wires. The control board shall use sensor and communication inputs to maintain refrigerant pressure by controlling each EC fan on the same refrigerant circuit to the same speed. The Control Board shall be rated to a temperature of –30°F to 125°F (–34.4°C to 51.7°C) and shall be factory-set for fan speed control.
   3. The mode of the unit shall be controlled by the controller and shall be in either DX, Economizer, or Idle Mode by each refrigerant circuit. Dual circuit condensers shall operate fans to meet airflow needs and mode of each circuit independent of the other. Fan(s) on common refrigerant circuit shall operate in synchronous speed when that circuit is active.
   4. A locking-type disconnect switch shall be factory-mounted and wired to the electrical panel and be capable of disrupting the flow of power to the unit and controlled via an externally mounted locking and lockable door handle. The locking disconnect shall be lockable in support of lockout/tagout safety programs.
   5. Short Circuit Current Rating. The electrical panel shall provide at least 65,000A SCCR.

E. Cabinet
   1. The condenser cabinet shall be constructed of bright aluminum sheet and divided into individual fan sections by full-width baffles. Internal structural support members, including coil support frame, shall be galvanized steel for strength and corrosion resistance. Panel doors shall be provided on two sides of each coil/fan section to permit coil cleaning. An electrical panel shall be contained inside a factory mounted NEMA 3R weatherproof electrical enclosure. Units with the 575V option shall include a second, factory mounted, NEMA 3R weatherproof electrical enclosure opposite the main electrical enclosure.

F. Economizer
   1. Condenser assembly shall include a variable speed refrigerant pump economizer module. Refrigerant pumps shall be housed in an enclosure with each pump dedicated to its own refrigerant circuit. During cold outdoor temperatures, the refrigerant pumps shall circulate refrigerant through the system in lieu of operating the compressors. The compressors shall ramp down during economizer operation and turn off completely if economizer is able to completely offset the load.

G. Condenser Accessories
   1. Options and accessories shall be as called for on the equipment schedules.

2.04 CONTROLS

A. Shall be microprocessor-based with a 7-inch, high-definition, capacitive, color touchscreen display and shall be mounted in an ergonomic, aesthetically pleasing housing. The display and housing shall be viewable while the front panel is open or closed. The controls shall be menu driven. The system shall display user menus for active alarms, event log, graphic data, unit view/status overview (including the monitoring of room conditions, operational status in percentage of each function, date and time), total run hours, various sensors, display setup and service contacts. A password shall be required to make system changes. Service menus shall include setpoints, standby settings (lead/lag), timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards and diagnostics/service mode. The control shall provide Ethernet/RS-485 ports dedicated for BMS connectivity (i.e., Base-Comms).
   1. Password Protection – shall contain two unique passwords to protect against unauthorized changes. An auto hide/show feature allows the user to see applicable information based on the login used.
   2. Unit Backup and Restore – The user shall be able to create safe copies of important control parameters. Shall have the capacity for the user to automatically backup unit configuration settings to internal memory or USB storage drive. Configuration settings may be transferred to another unit for a more streamlined unit startup.
   3. Parameter Download – Shall enable the user to download a report that lists parameter names, factory default settings and user-programmed settings in .csv format for remote reference.
   4. Parameter Search – Shall have search fields for efficient navigation and parameter lookup.
   5. Parameter Directory – Shall provide a directory that lists all parameters in the control. The list shall provide Line ID numbers, parameter labels, and current parameter values.
   6. Context-Sensitive Help – Shall have an on-board help database. The database shall provide context sensitive help to assist with setup and navigation of the menus.
   7. Display Setup – The user shall have the ability to configure the information based on the specific user's preference. Language, units of measure, screen contrast, home screen layout, back-light timer and the hide/show of certain readouts shall be configurable through the display.
   8. Additional Readouts – shall permit the user to configure custom widgets on the main screen. Widget options shall include items such as fan speed, call for cooling, call for free-cooling, maintenance status, call for hot water reheat, call for electric reheat, call for dehumidification, call for humidification, airflow, static pressure, fluid flow rate and cooling capacity.
   9. Status LEDs – shall provide the user with the unit's operating status using an integrated LED. The LED shall indicate if the unit has an active alarm; if the unit

has an active alarm that has been acknowledged; or if the unit is On, Off or in standby status.

10. Event Log – shall automatically store the last 400 unit-only events (messages, warnings, and alarms).
11. Service Contact Information – shall have the ability to store the local service or sales contact information.
12. Upgradeable – firmware upgrades shall be performed through a USB connection.
13. Timers/Sleep Mode – The menu shall allow various customer settings for turning the unit On or Off.
14. Menu Layout – The menus shall be divided into two main menus: User and Service. The User screen shall contain the menus to access parameters required for basic unit control and setup. The Service screen shall be designed for service personnel and shall provide access to advanced control setup features and diagnostic information.
15. Sensor Calibration – The menus shall allow unit sensors to be calibrated with external sensors.
16. Maintenance/Wellness Settings – The menus shall allow reporting of potential component problems before they occur.
17. Options Setup – The menus shall provide operation settings for the installed components.
18. Auxiliary Boards – The menus shall allow setup of optional expansion boards.
19. Various Sensors – The menus shall allow setup and display of optional custom sensors. The control shall include four customer-accessible analog inputs for sensors provided by others. The analog inputs shall accept a 4 to 20mA signal. The user shall be able to change the input to 0 to 5VDC or 0 to 10VDC. The gains for each analog input shall be programmable from the front display. The analog inputs shall be able to be monitored from the front display. When configuring the analog inputs, the selectable items to choose shall include air pressure, fluid pressure, temperature, percentage, general amperage, condenser amps, compressor amps, reheat amps, humidifier amps, unit amps, fan amps factory standard, and not used.
20. Diagnostics/Service Mode – control shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as On or Off at the front display. Control outputs shall be able to be turned On or Off from the front display without using jumpers or a service terminal. Each control output shall be indicated by an LED on a circuit board.
21. Base-Comms for BMS Connectivity – controller shall provide one Ethernet Port and RS-485 Port dedicated for BMS Connectivity. Provides ground fault isolated RS-485 Modbus, BACnet IP & Modbus IP network connectivity to Building Management Systems for unit monitoring and management. Also, provides ground fault isolated 10/100 baseT Ethernet connectivity for unit monitoring and management. The supported management interfaces include: SNMP for Network Management Systems, HTTP for web page viewing, SMTP for email, and SMS for mobile messaging. Controller can support dual IP on a single network and one 485 protocol simultaneously.

22. DSE System Optimization – Allows for efficiency improvements for the DSE system during EconoPhase mode. By optimizing liquid refrigerant temperature and pressure setpoints, the result is a reduction in power consumption of the condenser fan during mid and high ambient conditions. DSE System Optimization provides an opportunity for additional energy savings by increasing the utilization of the PRE-pumps and decreasing the utilization of the condenser fans, but always maintaining appropriate heat capacity rejection during mid to high ambient outdoor conditions. Energy savings occurs when utilizing the PRE-pump package; a pump consumes roughly 1/10th of the power consumed by the compressor.

B. Alarms
   1. All unit alarms shall be annunciated through both audio and visual cues, clearly displayed on the screen, automatically recorded in the event log and communicated to the customer's Building Management System/Building Automation System. Control shall activate an audible and visual alarm in the event of any of the following conditions:
      a. High Temperature
      b. Low Temperature
      c. High Humidity
      d. Low Humidity
      e. EC Fan Fault
      f. Change Filters
      g. Loss of Air Flow
      h. Loss of Power
      i. Compressor Overload
      j. Humidifier Problem
      k. High Head Pressure
      l. Low Suction Pressure
      m. Custom Alarms
   2. Custom alarm inputs shall be provided to indicate facility-specific events. Custom alarms can be identified with programmable labels. Frequently used alarm inputs shall include:
      a. Leak Under Floor
      b. Smoke Detected
      c. Standby Unit On
   3. Each alarm (unit and custom) shall be separately enabled or disabled, selected to activate the common alarm and programmed for a time delay of 0 to 255 seconds.

C. Control Methods and Options
   1. Unit shall be factory-set to allow precise monitoring and control of the condition of the air entering and leaving the unit. This control shall include predictive methods to control air flow and cooling capacity-based control sensors installed. Proportional and Tunable PID shall also be user- selectable options.

D. Controlling Sensor Options

1. Shall be flexible in the sense that it shall allow for controlling the capacity and fan from multiple different sensor selections. The sensor selections shall be:
    a. Cooling Capacity
        1) Supply
        2) Remote
        3) Return
    b. Fan Speed
        1) Supply
        2) Remote
        3) Return
        4) Manual (for diagnostics or to receive a signal from the BMS through remote monitoring devices or analog input)
        5) Static Pressure

E. Temperature Compensation
    1. Shall be able to adjust the capacity output based on supply and return temperature conditions to meet SLA guidelines while operating at highest efficiency.

F. Humidity Control
    1. Dew point and relative humidity control methods shall be available (based on user preference) for humidity control within the conditioned space.

G. Standby/Lead-Lag
    1. Shall allow scheduled rotation to keep equal run time on units and provide automated emergency rotation of operating and standby units.

H. Compressor Short Cycle Control
    1. Compressor short cycle control shall be available to prevent compressor short-cycling and needless compressor wear.

I. Condenser and Economizer Communication
    1. The controller shall communicate directly with the condenser and/or economizer unit via field-supplied CANbus communication wires and via field-supplied, low voltage interlock wires. This communication shall allow the controller to control modes and operation and to monitor their health and alarm status.

J. Wired Supply Sensor
    1. Each unit shall have one factory-supplied and connected supply air sensor that may be used as a controlling sensor or reference. When multiple sensors are applied for control purposes, the user shall be able to control based on a maximum or average temperature reading.

K. System Auto Restart
    1. The auto restart feature shall automatically restart the system after a power failure. Time delay shall be programmable. An optional capacitive buffer may be provided for continuous control operation through a power outage.

L. Sequential Load Activation
    1. On initial start-up or restart after power failure, each operational load shall be sequenced with a minimum of one second delay to minimize total inrush current.

M. Low Pressure Monitoring
    1. Units shall ship standard with low-pressure transducers for monitoring individual compressor suction pressure. If the pressure falls due to loss of charge or other mechanical cause, the corresponding circuit shall shut down to prevent equipment damage. The user shall be notified of the low-pressure condition through the local display and remote monitoring.

N. Winter Start Time Delay
    1. An adjustable software timer shall be provided to assist with compressor starting during cold weather. When the compressor starts, the low-pressure input shall be ignored for the period set in the user- adjustable timer. Once the delay after the compressor start has elapsed, the low-pressure input should remain in the normal state. If the low-pressure input does not remain in the normal state after the delay has elapsed, the circuit shall lock out on low pressure. The low-pressure alarm shall be announced on the local display and communicated to remote monitoring systems.

O. Advanced Freeze Protection
    1. Units shall ship standard with advanced freeze protection enabled. The advanced freeze protection shall monitor the pressure of each circuit using a transducer. The control shall interact with the fan and compressor to prevent the unit coil from freezing if circuit suction pressure drops. Applying fan speed to direct expansion systems requires limitations to avoid freezing condensate on the coil when the unit operates below 100% fan speed. The unit's advanced freeze protection shall provide the ability to predict freeze conditions and correct this condition automatically by adjusting fan speed and compressor capacity. If a freeze condition is detected, the user shall be notified through the local display and remote monitoring systems.

P. Advanced High-Pressure Protection
    1. When the compressor is initially activated, the system shall be monitored for a high pressure. When high pressure is detected, the control shall reduce the system discharge pressure by altering the compressor loading and the condenser fan speed, preventing circuit shut down. If the unit is unsuccessful in correcting the problem through this interaction, an alarm shall occur, and the affected compressor shall be immediately locked off. The control shall automatically re-enable the compressor when pressure returns to a safe level.

Q. Refrigerant Pressure Transducer Failure
    1. The control shall monitor the high-side and low-side refrigerant pressure transducers. If the control senses that the transducer has failed, has been disconnected, shorted or the reading has gone out of range, the user shall be

notified through the local display and remote monitoring. The corresponding circuit that the failure has occurred on shall be disabled to prevent unit damage.

R. Oil Return Protection
   1. The control shall monitor compressor operation and staging to ensure that liquid and hot gas velocity are maintained for proper oil return to the compressor.

S. Digital Scroll High Temperature Protection
   1. The control shall monitor digital scroll temperature during unit operation. A compressor temperature limit shall be imposed to help prevent damage to the compressor. If the temperature reaches the maximum temperature limit, the compressor shall be locked out for 30 minutes and an alarm shall be annunciated on the local display and through monitoring. After the initial lockout, the control shall continue to monitor compressor temperature during the off-cycle and re-enable the circuit once a safe operating temperature is reached and the 30 minutes has elapsed. The control shall store the number of high-temperature trips. The number of trips shall be accessible through the local display.

T. Digital Scroll Sensor Failure
   1. The control shall monitor the status of the digital scroll sensor(s). If the control senses the thermistor becomes disconnected, shorted or the reading goes out of range, the user will be notified through an event on the local display and remote monitoring.

U. Compressor Sequencing
   1. A user-selectable compressor sequencing parameter shall be provided and access through the local control. This sequencing parameter presents the user with three choices:
      a. Always use Compressor 1 as lead compressor.
      b. Always use Compressor 2 as lead compressor.
      c. Auto: The unit shall automatically stage compressors to keep each unit's run time within 8 hours of the other unit's run time.
         1) NOTE: The Auto setting attempts to maintain equal run times between compressors. However, the control will not turn Off a compressor to equalize run time when it is needed to control the space.
      d. First Priority – If the safety timings are acceptable for only one compressor, that compressor shall be the next to be started/stopped.
      e. Second Priority – If both compressors are Off, the one with fewer working hours shall be the next to start.
      f. Third Priority – If both compressors are in operation, the one that has been operating longer since the last start shall be the next to be stopped.

V. Compressor High and Low Temperature Limit Protection
   1. The control shall monitor the return air to ensure that the compressor(s) are operated within the manufacturer's defined window of operation. If the return air temperature deviates from the manufacturer's window of operation, the controller

shall automatically adjust to prevent damage to the cooling unit or reduction in its reliability.

W. Compressor Run Time Monitoring
   1. The control shall log these compressor statistics:
      a. Number of compressor starts
      b. Run hours
      c. Average run time
      d. Starts per day
      e. Starts per day worst
      f. Number of high-pressure alarms
      g. Operating phase in which the high-pressure alarm occurred
      h. Number of low-pressure alarms
      i. Operating phase in which the low-pressure alarm occurred
      j. Number of compressor overloads
      k. Number of high-temperature alarms (scroll compressors)
   2. The user shall have the ability to monitor compressor operating temperature and pressure from the local display to be used as a diagnostic tool.

X. Manual Compressor Disablement
   1. The user shall have the ability to disable compressor operation using a set of either normally open or normally closed dry contacts tied directly to the control or through remote monitoring. An additional enable/disable feature shall be provided to allow the user to permanently disable an individual compressor circuit for maintenance using the local display.

Y. Manual Compressor Operation
   1. The user shall be able to operate each compressor manually from the local display. The user shall be able to energize refrigeration components including liquid-line solenoid valves, compressor contactors, electronic expansion valves and adjust capacity for troubleshooting or repair. The control shall monitor the compressor during manual operation and shall shut the compressor down if needed to prevent electrical or mechanical damage.

2.05 MISCELLANEOUS OPTIONS

A. High-Temperature Sensor
   1. The high-temperature sensor shall be factory-installed in the unit and shall be factory-set to 125ºF (52ºC). It shall immediately shut down the environmental control system when activated. The sensor shall be mounted with the sensing element in the return air.

B. Smoke Sensor
   1. The smoke sensor shall immediately shut down the Thermal Management system and activate the alarm system when activated. The smoke sensor shall be mounted in the electrical panel with the sensing element in the return air compartment. The smoke sensor is not intended to function as or replace any room smoke detection

system that may be required by local or national codes. The smoke sensor shall include a supervision contact closure.

C. Condensate Pump, Dual Float
   1. The pump shall becomplete with integral dual-float switches, pump-and-motor assembly and reservoir. The secondary float shall send a signal to the local alarm and shut down the unit upon high water condition.

D. Low Voltage Terminal Package
   1. Factory-installed and factory-wired terminals shall be provided.
      a. Remote Shutdown Terminals – 2 additional pairs of terminals provide the customer with additional locations to remotely shut-down the unit by field-installed devices or controls.
      b. Extra Common-Alarm Contacts – 2 additional pairs of terminals provide the customer with normally-open contacts for remote indication of unit alarms.
      c. Main-Fan Auxiliary Switch – 1 set of normally-open contacts wired to the EC-fan motor contactor will close when EC-fan operation is required. This set of dry contacts could also be used to initiate air economizer operation. Air economizer and associated devices by others.
      d. Vertiv™ Liebert® Liqui-tect™ Shutdown – 1 pair of dry contacts for the Liebert® Liqui-tect™ sensor signal will provide unit shut down. (Liebert® Liqui-tect™ sensor is not included.)
   2. EC Fan Overload
      a. EC fan fault
   3. Compressor Overload
      a. A pair of N/O contacts shall be factory-installed and wired to each compressor to indicate Compressor Overload.

E. Sensors, Maximum of 2 Per Unit - Optional
   1. Solid state water sensors shall be provided for installation under the raised floor.

F. Discharge Air Plenum
   1. The air plenum shall be constructed of 20-gauge steel, powder coated to match unit color. Air shall discharge from the top of the plenum. Top of plenum shall be flanged for connection of ductwork.

G. Additional options and accessories shall be as called for on the equipment schedules.

PART 3 - EXECUTION

3.01 GENERAL

A. Install all equipment, piping, and controls in accordance with manufacturer's installation instructions.

B. Mount the thermostats. Coordinate exact locations with the Owner.

C. Install the drain lines. Pitch drain lines downwards at minimum 1/8" per foot in the direction of flow.

D. Engage manufacturer's field service technician to provide warranty start-up supervision, assist in programming of unit controls and ancillary devices supplied by them, and provide completed startup checklist to the Engineer and Owner.

E. Install new filters on indoor units.

F. Clean all equipment after installation.

+ + END OF SECTION + +

SECTION 15748

VARIABLE REFRIGERANT FLOW SPLIT UNITS

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTION

A. The systems shall consist of an outdoor heat pump unit with variable speed compressor technology, one or more indoor unit(s), and one or more wired indoor controller(s).

1.02 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be rated in accordance with Air Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 210/240 and bear the AHRI Certification label.

D. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

1.04 WARRANTY

A. Contractor shall ensure that all units are registered with the manufacturer to ensure all warranties are in place after installation.

B. Parts shall be warranted for a period of one (1) year from date of installation.

C. Compressors shall be warranted for an additional period of (6) years after the end of the standard parts warranty.

1.05 SUBMITTALS

A. Submit manufacturer's product data including capacity of unit, electrical requirements, airflow, sound pressure data, indoor and outdoor unit measurements, weight, control schematics, and wiring diagrams.

PART 2 - PRODUCTS

2.01 GENERAL

A. One or more indoor units shall be paired with each outdoor unit as indicated on the plans and schedules.

B. The manufacturer shall size all refrigerant piping and shall provide shop drawing indicating layout of refrigerant piping for each system.

C. Acceptable manufacturers, subject to submittal review, include:
   1. LG
   2. Daikin
   3. Mitsubishi

2.02 INDOOR UNITS - 4-WAY CEILING CASSETTES

A. General:
   1. Unit shall be factory assembled, wired, piped and run tested.
   2. Unit shall be designed to be installed for indoor application.
   3. Unit shall be designed to mount recessed in the ceiling and has a surface mounted grille on the bottom of the unit.

B. Casing/Panel:
   1. Unit case shall be manufactured using galvanized steel plate.
   2. The unit shall be provided with an off-white Acrylonitrile Butadiene Styrene (ABS) polymeric resin architectural grille.
   3. The grille shall have a tapered trim edge, and a hinged, spring clip (screw-less) return air filter-grille door.
   4. Unit shall be provided with metal ears designed to support the unit weight on four corners.
   5. Ears shall have pre-punched holes designed to accept field supplied all thread rod hangers.

C. Cabinet Assembly:
   1. Unit shall have four supply air outlets and one return air inlet.
   2. The supply air outlet shall be through four-directional slot diffuser each equipped with independent oscillating motorized guide vane designed to change the airflow direction.
   3. The grille shall have a discharge range of motion of 40° in an up/down direction with capabilities of locking the vanes.
   4. The unit shall have a guide vane algorithm designed to sequentially change the predominant discharge airflow direction in counterclockwise pattern.
   5. Guide vanes shall provide airflow in all directions.
   6. Unit shall be equipped with factory installed temperature thermistors for:
      a. Return air
      b. Refrigerant entering coil

c. Refrigerant leaving coil
7. Unit shall have a factory assembled, piped and wired electronic expansion valve (EEV) for refrigerant control.
8. Unit shall have a built-in control panel to communicate with other indoor units and to the outdoor unit.
9. The unit shall have factory designated branch duct knockouts on the unit case.
10. The unit shall have provision of fresh air ventilation through a knock-out on the cabinet.
11. The branch duct knockouts shall have the ability to duct up to ½ the unit airflow capacity.
12. The branch duct cannot be ducted to another room.
13. Unit shall have the following functions as standard:
    a. Self-diagnostic function
    b. Auto addressing
    c. Auto restart function
    d. Auto operation function
    e. Child lock function
    f. Forced operation
    g. Dual thermistor control
    h. Sleep mode
    i. Dual setpoint control
    j. Filter life and power consumption display

D. Fan Assembly:
1. The unit shall have a single, direct drive, turbo fan made of high strength ABS HT-700 polymeric resin.
2. The fan impeller shall be statically and dynamically balanced.
3. The fan motor is Brushless Digitally controlled (BLDC) with permanently lubricated and sealed ball bearings.
4. The fan motor shall include thermal, overcurrent and low RPM protection.
5. The fan/motor assembly shall be mounted on vibration attenuating rubber grommets.
6. The fan speed shall be controlled using microprocessor based direct digitally controlled algorithm.
7. In cooling mode, the indoor fan shall have the following settings: Low, Med, High, Power Cool, and Auto.
8. In heating mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.
9. Unit shall have factory installed motorized louver to provide flow of air in up and down direction for uniform airflow.

E. Filter Assembly:
1. The return air inlet shall have a factory supplied removable, washable filter with antifungal treatment.
2. The unit shall have the option for a secondary plasma filter accessory.
3. The filter access shall be from the bottom of the unit.

4. The unit shall have provision for an optional auto-elevating grille kit designed to provide motorized ascent/descent of the return air grille/pre filter assembly.
    a. The ascent/descent of the return air grille shall be up to a distance of 14-3/4 feet allowing access to remove and clean the filter.
    b. The auto-elevating grille shall have a control algorithm to accept up, down and stop control commands from the controller.
    c. The auto-elevating grille shall have a control to stop the descent automatically if a contact is made with any obstacle.

F. Coil Assembly:
1. Unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.
2. The copper tubing shall have inner grooves for high efficiency heat exchanger.
3. Unit shall have a minimum 1 or 2 row coil, 18-19 fins per inch.
4. Unit shall have a factory supplied condensate drain pan below the coil constructed of EPS (expandable polystyrene resin).
5. Unit shall include an installed and wired condensate drain pump capable of providing minimum 27.5 inch lift from bottom surface of the unit.
6. The drain pump shall have a safety switch to shut off the unit if condensate rises too high in the drain pan.
7. Unit shall have provision of 45° flare refrigerant pipe connections.
8. The coil shall be factory pressure tested at a minimum of 551 psig.
9. All refrigerant piping from outdoor unit to indoor unit shall be field insulated.

G. Microprocessor Control:
1. The unit shall have a factory installed microprocessor controller capable of performing functions necessary to operate the system.
2. The unit shall be able to communicate with other indoor units and the outdoor unit using a field supplied minimum of 18 AWG, 2 core, stranded and shielded communication cable.
3. The unit controls shall operate the indoor unit using one of the five operating modes:
    a. Auto
    b. Heating
    c. Cooling
    d. Dry
    e. Fan only

H. Electrical:
1. The unit electrical power shall be as called for on the schedules.
2. The unit shall be capable of operating within voltage limits of +/- 10% of the rated voltage.

I. Controls:

1. Unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently and communicate with the outdoor unit.

J. Options:
   1. All options and accessories shall be as called for on the schedules.

2.03 INDOOR UNITS - HORIZONTAL DUCTED UNITS

A. General:
   1. Unit shall be factory assembled, wired, piped and run tested.
   2. Unit shall be designed to be installed for indoor application.
   3. Unit shall be designed to mount fully concealed above the finished ceiling.
   4. Unit shall have opening to supply air from front horizontal and a dedicated rear horizontal return.
   5. The supply air shall be flanged for field installed ductwork that shall not exceed the external static pressure limitation of the unit.

B. Casing/Panel:
   1. Unit case shall be manufactured using galvanized steel plate.
   2. The cold surfaces of the unit shall be covered internally with a coated polystyrene insulating material.
   3. The cold surfaces of the unit shall be covered externally with sheet insulation made of Ethylene Propylene Diene Monomer (M-Class) (EPDM)
   4. The external insulation shall be plenum rated and conform to ASTM Standard D1418.
   5. Unit shall be provided with hanger brackets designed to support the unit weight on four corners.
   6. Hanger brackets shall have pre-punched holes designed to accept field supplied, all thread rod hangers.

C. Cabinet Assembly:
   1. Unit shall have supply air discharge outlets horizontal and a return air inlet horizontal.
   2. Unit shall be equipped with factory installed temperature thermistors for:
      a. Return air
      b. Refrigerant entering coil
      c. Refrigerant leaving coil
   3. Unit shall have a factory assembled, piped and wired electronic expansion valve (EEV) for refrigerant control.
   4. Unit shall have a built-in control panel to communicate with other indoor units and to the outdoor unit.
   5. Unit shall have the following functions as standard:
      a. Self-diagnostic function
      b. Auto addressing
      c. Auto restart function
      d. Auto operation function

e. Child lock function
f. Forced operation
g. Dual thermistor control
h. Sleep mode
i. External static pressure (ESP) control
j. Dual setpoint control
k. Filter life and power consumption display

D. Fan Assembly:
1. The unit shall have two direct drive Sirocco fans made of high strength ABS GP-2200 polymeric resin.
2. The fan impeller shall be statically and dynamically balanced.
3. The fans shall be mounted on a common shaft.
4. The fan motor is Brushless Digitally controlled (BLDC) with permanently lubricated and sealed ball bearings.
5. The fan motor shall include thermal, overcurrent and low RPM protection.
6. The fan/motor assembly shall be mounted on vibration attenuating rubber grommets.
7. The fan speed shall be controlled using microprocessor based direct digitally controlled algorithm.
8. In cooling mode, the indoor fan shall have the following settings: Low, Med, High, Power Cool, and Auto.
9. In heating mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.
10. Each of the settings can be field adjusted from the factory setting (RPM/ESP).
11. Unit shall be designed for high speed air volume against an external static pressure of up to 0.98” water gauge.

E. Filter Assembly:
1. The return air inlet shall have a factory supplied removable, washable filter with antifungal treatment.
2. The filter access shall be from the rear of the unit.

F. Coil Assembly:
1. Unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.
2. The copper tubing shall have inner grooves for high efficiency heat exchanger.
3. Unit shall have a minimum 2-3 row coil, 19-21 fins per inch.
4. Unit shall have a factory supplied condensate drain pan below the coil constructed of HIPS (high impact polystyrene resin).
5. Unit shall include an installed and wired condensate drain pump capable of providing minimum 27.5 inch lift from bottom surface of the unit.
6. The drain pump shall have a safety switch to shut off the unit if condensate rises too high in the drain pan.
7. Unit shall have provision of 45° flare refrigerant pipe connections.
8. The coil shall be factory pressure tested at a minimum of 551 psig.

9. All refrigerant piping from outdoor unit to indoor unit shall be field insulated.

G. Microprocessor Control:
   1. The unit shall have a factory installed microprocessor controller capable of performing functions necessary to operate the system.
   2. The unit shall be able to communicate with other indoor units and the outdoor unit using a field supplied minimum of 18 AWG, 2 core, stranded and shielded communication cable.
   3. The unit controls shall operate the indoor unit using one of the five operating modes:
      a. Auto
      b. Heating
      c. Cooling
      d. Dry
      e. Fan only

H. Electrical:
   1. The unit electrical power shall be as called for on the schedules.
   2. The unit shall be capable of operating within voltage limits of +/- 10% of the rated voltage.

I. Controls:
   1. Unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently and communicate with the outdoor unit.

J. Options:
   1. All options and accessories shall be as called for on the schedules.

2.04 OUTDOOR UNITS - SINGLE-PHASE UNITS

A. Casing:
   1. Outdoor unit casing shall be constructed of 22-gauge heavy duty steel. An easily removable front panel shall be provided to allow access to major components and control devices. Casing shall be supplied with lifting handles in four locations and a unit base rail with built in lifting channels designed to accommodate a standard forklift.
   2. Exterior surfaces shall be cleaned, and finished with weather resistant baked enamel finish applied using a powder-coat process. Outdoor unit casings shall be tested a minimum of 500 hours a salt spray test using ASTM B117.
   3. Condenser fan guards shall be provided and made of heavy gauge, heavy duty polymer resin. The outdoor unit coil shall be protected with a heavy gauge steel wire guard finished with a powder coat finish.

B. Refrigeration System:
   1. The system shall have a single refrigeration circuit and use refrigerant R-410a.

2. The outdoor unit shall be with factory installed components including a refrigeration filter dryer, check valves, oil separator(s), accumulator, hot gas bypass valve, 4-way reversing valve, electronic controlled thermal expansion valve (EEV), high and low side charging ports, and interconnecting piping.
3. The outdoor unit shall be equipped with an integral subcooling circuit consisting of a plate-type heat exchanger and an electronically controlled thermal expansion valve (EEV) capable of providing a minimum of 20º F subcooling.

C. Refrigeration Oil Control:
1. Refrigeration oil levels in the compressor crankcase shall be maintained using a three stage oil control system. The compressor discharge port shall be equipped with an oil filtering device designed to restrict oil loss from the compressor. The high pressure discharge vapor shall leave the compressor an immediately enter an oil separator designed to use centrifugal force to extract oil vapor from the refrigerant gas stream. The outdoor unit microprocessor shall be equipped with a control algorithm designed to control the position of the electronic expansion valves located in the indoor units. The algorithm shall monitor the amount of time each indoor unit expansion valve has remained in the closed position. For every expansion valve that has been closed for a period of four hours, the algorithm shall open the valve and allow refrigerant flow for a minimum of three minutes.

D. Single Inverter/ Compressor:
1. Units shall be equipped with one hermetic digitally controlled (DC) inverter driven scroll compressor. The compressor scroll shall be specifically designed for the refrigerant provided and shall be made by the unit manufacturer and shall be engineered for a minimum run-time of 21, 500 hours.
2. The compressor frequency inverter shall be designed and manufactured by the outdoor unit manufacturer and be capable of providing a minimum modulation range from 25 to 105Hz.
3. The compressor motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of nameplate voltage. The compressor shall be equipped with a crankcase heater, internal temperature, and current sensing motor overloads. External suction and discharge temperature and pressure sensors shall be provided to protect the compressor from damage caused by over temperature or over pressure conditions.
4. The compressor shall be provided with a positive displacement oil pump and oil injection device capable of providing a sufficient bearing oil film on all bearing surfaces across the entire inverter modulation range.
5. Compressor bearing shall be provided with a Teflon® coating on all wear surfaces.
6. The scroll type compressor shall provide inherently low vibration and noise by having no suction and discharge valves. The compressor compartment shall be lined with sound attenuating insulation and mounted on isolation pads to avoid transmission of mechanical vibration.

E. Outdoor Unit Coil:
1. Outdoor unit coils shall be a minimum of two rows and manufactured using non-ferrous materials. Tubes shall be copper. Fin material shall be aluminum with a

stamped louvered configuration. Fin material shall be finished with a factory applied Gold-Fin™ corrosion resistant hydrophilic silica gel coating prior to coil assembly. Coil coating shall be tested using ASTM B117 salt spray test procedure for a minimum 1000 hours. Coils shall be burst tested at a minimum of 500 psig.

F. Outdoor Unit Fans and Motors:
   1. Outdoor units shall be furnished with a minimum of two direct-drive propeller type fans designed to provide horizontal airflow from the rear to the front of the unit. Fan blades shall be 20-1/2" statically and dynamically balanced propeller fans made of durable Lupos (ABS) polymer resin.
   2. Motors shall be designed to operate at a maximum speed of 950 rpm to assure quiet operation. Each fan shall be driven by a digitally controlled inverter that varies the fan speed from zero to maximum design speed.
   3. The fan motor shall be a designed and built by the unit manufacturer. The motor shall be a brushless digitally controlled (DC) design and have permanently lubricated ball bearings and inherent overload and over temperature protection.
   4. The fan speed shall be controlled using a microprocessor based direct digital control algorithm that provides a minimum of three pre-programmed field adjustable fan speeds.
   5. Fans control algorithm shall provide a night-time (off peak) fan speed limiting control that reduces unatttenuated, fan generated noise by a total of 10 DBA in three steps. Algorithm shall provide three field selectable off-peak operation schedules.

G. Outdoor Unit Controls:
   1. Outdoor units shall be completely factory wired with necessary electrical control components, printed circuit boards, thermistors, sensors, terminal blocks and contactor lugs for power wiring. Control wiring circuit shall be 24-volt which includes control power transformer and fuses. Solid state microprocessor based algorithms shall provide outdoor unit component protection, soft-start capability, refrigeration system pressure and temperature control, defrost and low ambient controls. Unit shall be designed for continuous operation from -4º F to 110ºF.
   2. The microprocessor shall have an algorithm designed to adjust the outdoor unit fan speed for installations using a field supplied snow hood, hail guards, or installations with a ducted supply, and/or discharge air plenum. The setting shall be field selectable for 0.00", 0.08" or 0.16" wg external static pressure.
   3. While operating in the heating mode, the outdoor unit shall have an automatic defrost control cycle designed to cycle the compressor operation based on indoor unit low pressure vapor pipe temperature.
   4. When the system is started, the connected indoor units shall be assigned an electronic unit address automatically by the outdoor unit microprocessor or manually by the installer.
   5. The microprocessor shall have a refrigeration system pump-down cycle that will isolate up to 17.6 lbs of the system refrigerant charge into the outdoor unit coil. The unit shall be equipped with back-seat valves that isolate the units' initial charge in the outdoor unit refrigeration circuit.

6. The microprocessor shall have a refrigeration system pump-out cycle designed to evacuate the majority of the system refrigerant charge from the outdoor unit. The unit shall be equipped with factory installed back-seat valves used to isolate the outdoor unit from the balance of the refrigeration system.
7. The microprocessor shall have a cooperative control algorithm that automatically adjusts distribution of refrigerant in the system to prevent any one indoor unit from being starved for refrigerant.
8. Upon unit malfunction, power outage, or system shutdown, the microprocessor shall store up to the last 3000 system events or system events that occurred over the last 30 days into non-volatile EEPROM memory.
9. The active system malfunction codes shall be communicated using a three-digit, seven-segment display on the microprocessor board. The microprocessor shall have an algorithm that actively verifies the operational condition of system sensors and thermistors.
10. The microprocessor shall have the ability to verify the system is undercharged, overcharged, or correct.

H. Options:
1. All options, accessories, and electrical requirements shall be as called for on the schedules.

PART 3 - EXECUTION

3.01 GENERAL

A. Install all equipment, piping, and controls in accordance with manufacturer's installation instructions.

B. Mount the controllers. Coordinate exact locations with the Owner.

C. Install the drain lines. Pitch drain lines downwards at minimum 1/8" per foot in the direction of flow.

D. Install new filters on indoor units.

E. Clean all equipment after installation.

+ + END OF SECTION + +

SECTION 15768

HYDRONIC UNIT HEATERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Hydronic (heating hot water) Unit Heaters

1.02 RELATED SECTIONS

A. Section 15180 - Pipes, Valves and Fittings for HVAC Systems

B. Section 15184 - Piping Specialties for HVAC Systems

C. Section 15940 - Sequence of Operations for HVAC Systems

D. Section 15990 - Testing, Adjusting, and Balancing of Air and Hydronic HVAC Systems

1.03 SUBMITTALS

A. Submit for review, products and procedures utilized under this Contract per the requirements of section 01300-Submittals. Submissions shall include but not be limited to:
   1. Hyrdonic Unit Heaters Product Data Submittal
      a. Submit manufacturer's catalog sheets, brochures, performance charts, specifications and installation instructions.
      b. Submit maintenance instructions and spare parts lists. Include this data, product data, shop drawings and schedule in maintenance manuals in accordance with Division 01.

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications
   1. Firms regularly engaged in manufacturing of unit heaters, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Unit heaters shall be shipped from the factory in suitable protective covering. Store unit heaters and components in clean dry place. Protect from weather, fumes, water, construction debris, and physical damage.

PART 2 - PRODUCTS

2.01 HYDRONIC UNIT HEATERS

A. Unit heater shall consist of an enclosed, extended-surface heating element with propeller-type fan, with capacity and electrical characteristics as shown on the drawings. The entire unit and controls shall be UL-labeled. Heater shall be mounted with threaded rod, unless directed otherwise by manufacturer, and be suitable for mounting with horizontal air discharge.

B. Hot Water Coil: Extended surface type, utilizing aluminum fins and DLP-type copper tubes with cast bronze supply and return connections. Coils shall be of serpentine design with horizontal tubes, vertical fins, and center supply and return connections. All tube bends shall be brazed. Tubes shall be mechanically bonded to the collars of the fins. Coils shall be capable of operating at hot water pressures and temperatures of 150 psig and 375°F. Coil shall be 4-rows and designed for use with low temperature hot water (catalogue ratings for 140°F entering water).

C. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard/motor mounting bracket; horizontal models with permanently lubricated sleeve bearings. Aluminum construction secured to a steel hub.

D. Cabinet shall be minimum 20 gauge steel treated to prevent corrosion and painted with a corrosion resistant, high solids gray-green finish. Casing top shall be provided with threaded rod connections for hanger rods. Provide horizontal and vertical louvers on the discharge for direction of the air.

E. Options and accessories shall be as called for on the Equipment Schedules.

F. Hydronic Unit Heaters shall be Lodronic Models HCH by Modine or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install unit heaters using threaded rod, sized according to unit tappings. Secure to structural support as required. Provide steel wall brackets where mounting from structure above would require excessive lengths of threaded rods.

B. Make electrical connections for power and controls as required by code.

C. Check the unit heater for proper operation, including safety controls.

+ + END OF SECTION + +

SECTION 15769

ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Electric Unit Heaters.

1.02 REFERENCES

A. Electric unit heaters shall meet the requirements of the National Electric Code (NEC) and shall be UL listed.

1.03 SUBMITTALS

A. Submit under provisions of Section 01300 - Submittals.

B. Submit manufacturer's product data and installation instructions to Engineer.

C. Submittal data shall include capacity and size of each heater and wiring instructions.

PART 2 - PRODUCTS

2.01 ELECTRIC UNIT HEATERS

A. Electric unit heater shall be Model HVH as manufactured by Chromalox or approved equal. Heater shall be suitable for horizontal or vertical mount. Refer to the drawings for mounting type.

B. Heater to be of the KW rating, voltage and phase specified in the schedule.

C. Unit cabinet shall be 20 gauge die formed furniture grade steel with integral adjustable louvers to provide control of discharged air. All metal surfaces of the case shall be phosphate coated to resist corrosion, and finished in attractive two-tone powder coated paint.

D. The electric heating bank shall be metal sheath fintube heating elements with furnace brazed fins for improved heat transfer. Automatic reset thermal overheat protection shall be wired for instantaneous de-energizing of built-in control of contactor holding coil in case of thermal overload.

E. Motor shall be of the totally enclosed continuous fan-duty sleeve bearing type equipped with built-in thermal overload protection. Each unit shall be equipped with a combination motor support resiliently mounted at four points to absorb any motor

vibration. Fans shall be aluminum, directly connected to fan motor, dynamically balanced and designed specifically for unit heater application.

F. Electrical: All units shall have built-in contactors and low voltage control circuit transformers to provide single-source power connection. Factory mounted disconnect switches shall be provided. A wiring diagram and grounding lug shall be included in each control compartment.

G. Supports: Stainless steel hanger rods, double nuts, and ceiling/wall bracket.

H. All options and accessories shall be as called for on the equipment schedules.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install units in accordance with manufacturer's published installation instructions.

B. Do not install unit heaters closer than 12 inches to combustible materials in any direction.

+ + END OF SECTION + +

SECTION 15810

SHEET METAL WORK FOR HVAC SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This Section describes the metal ductwork for HVAC duct systems and blower intake ductwork in accordance with SMACNA Duct Construction Standards, except as otherwise specified.

B. The construction material for each ductwork system shall be as listed in the "Ductwork Material Schedule" at the end of this Section.

C. This Section also describes the fittings, access doors, hangers and supports, manual volume dampers and sealants for each ductwork system as required.

1.02 RELATED WORK

A. Section 15060 - Hangers and Supports for HVAC Ductwork, Piping, and Equipment

B. Section 15990 - Testing, Adjusting, and Balancing of Air and Hydronic HVAC Systems

1.03 REFERENCES

A. ASHRAE - Handbook Fundamentals; Latest Edition.

B. SMACNA - HVAC Duct Construction Standards Metal And Flexible (latest issue)

C. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

D. ASTM B209 - Specifications for Aluminum and Aluminum-Alloy Sheet and Plate.

E. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

F. UL 555 S - Fire Dampers & Smoke Dampers.

G. NFPA 96 - Standard for Commercial Cooking Operations

H. New York State Mechanical Code.

1.04 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A and New York State Mechanical Code standards.

1.05 SUBMITTALS

A. Ductwork shop drawings for approval:
   1. Coordinate layout duct drawings that differ from ductwork shown on the Drawings.
   2. The review of deviations will be for pressure drop only. The review will not address clearances or accessibility to maintain or balance the air systems. No dimensional or coordination check of the shop drawings will be made. The Contractor has the sole responsibility to review the Drawings, coordinate ductwork fabrication, and provide clearances and access for installation, maintenance and balancing of this work, and work of other trades. Unless specifically dimensioned, Drawings indicate approximate locations only. The Contractor has the sole responsibility to locate and route the ductwork.
   3. Deviations such as changing direction or transforming or dividing ductwork must maintain ductwork cross-sectional area and not exceed transformation taper of 15 degrees.
   4. Plans and section showing all equipment and accessories.
   5. Minimum 3/8 in. scale, double line, showing sizes, transverse joints, transitions, elevations, clearances and accessories; sections where required.

B. Shop details and catalog cuts of:
   1. Ductwork construction, including gauge and bracing schedule
   2. Supports
   3. Dampers
   4. Turning vanes
   5. Fire dampers
   6. Access doors
   7. Flexible connections
   8. Blank off panels
   9. Silencers
   10. Other accessories

1.06 QUALITY ASSURANCE

A. Construct all ductwork in accordance with referenced SMACNA Standards, except as otherwise stated. Ductwork pressure classifications shall be in accordance with referenced SMACNA Standards, except as otherwise specified.

B. Construction pressure classification of ductwork are shown in this Section or on the Drawings.

C. All ductwork shall be free from pulsation, chatter, vibration and objectionable noise. If any of these defects appear after a system is in operation, correct by removing and replacing, or reinforcing the ductwork, at no additional cost to the Owner.

D. For all galvanized steel ductwork, zinc coating shall be minimum G90 per ASTM A653.

PART 2 - PRODUCTS

2.01 GALVANIZED STEEL RECTANGULAR DUCTS AND FITTINGS

A. Construct ducts of galvanized sheet steel meeting ASTM A 653 with G90 coating designation, and in accordance with the latest SMACNA HVAC Duct Construction Standards Metal And Flexible and pressure classifications as stated on the Drawings or in this Section.

B. HVAC ducts shall be no less than No. 22 U.S. Gauge. HVAC ductwork shall be 2" w.c. pressure class.

C. Blower intake ductwork shall be no less than No. 16 U.S. Gauge. Blower intake ductwork shall be 10" w.c. pressure class. Provide support members as required by SMACNA HVAC Duct Construction Standards for the given duct size at the 10" w.c. pressure class.

D. Piping, conduit and structure shall not penetrate ductwork. Where this condition cannot be avoided and with the written permission of the Architect/Engineer, follow SMACNA HVAC Duct Construction Standards Metal and Flexible, except that sides of transition sections shall slope a maximum of 15 degrees.

E. Provide 90-degree full-radius elbows with a centerline radius 1.5 times the duct width in the plane of the bend.

F. For elbows with centerline radius less than 1.5 times the width of the duct in the plane of the bend, provide turning vanes.

G. Provide square throat elbows with manufactured turning vanes.

H. All dissimilar metals shall be connected with flanged joints made up with fiber or neoprene gaskets to prevent contact between dissimilar metals. Flanges shall be fastened with bolts protected by ferrules and washers made of the same materials as the gaskets.

I. For split fittings, the split shall be proportional to the air flow. Construct per SMACNA HVAC Duct Construction Standards- Metal and Flexible.

J. Transitions and Offsets shall follow SMACNA HVAC Duct Construction Standards Metal and Flexible, except that sides of transitions shall slope a maximum of 15 degrees.

K. All branch take-offs perpendicular to the main shall be a 45 degree entry.

L. Longitudinal seams shall be of the Pittsburgh Lock type outlined in the SMACNA HVAC Duct Construction Standards Metal and Flexible.

M. Duct transverse joints shall be selected and used consistent with the static pressure class, applicable sealing requirements, materials involved, duct support intervals and

other provisions for proper assembly of ductwork outlined in the SMACNA HVAC Duct Construction Standards - Metal and Flexible. Transverse joints T-25a, T-25b (Ductmate) shall only be used. Metal clips will only be allowed (NO PVC). Ductmate shall not be used for the following (use transverse joints T-15 through T-24 in these cases):

1. The Ductmate '45' system shall not be used for applications with duct gauges heavier than 10 or lighter than 22.
2. The Ductmate '35' system shall not be used for applications with duct gauges heavier than 16 GA. or lighter than 26 GA.
3. The Ductmate '25' system shall not be used for application with duct gauges heavier than 20 GA. or lighter than 26 GA.

2.02 TURNING VANES

A. Manufactured with same material as ductwork that it is installed in and to the same pressure classification as ductwork that they are installed in.

B. Provide turning vanes in all square duct elbows and as noted on the Drawings.

C. Vanes shall be single thickness Small Vane as detailed in SMACNA HVAC Duct Construction Standards Metal and Flexible.

D. Where a rectangular duct changes in size at a square-throat elbow fitting, use single thickness turning vanes with trailing edge extensions aligned with the sides of the duct.

2.03 ACCESS DOORS

A. For access doors for use in ductwork receiving Fire Rated Blanket Insulation see Ductwork Insulation Section for requirements. Fabricate all other access doors in accordance with SMACNA Duct Construction Standards Metal And Flexible and as indicated.

B. For HVAC duct systems, construct doors of the same material as the ductwork. Minimum size of access doors shall be 8 inches by 8 inches, unless shown otherwise.

C. Provide walkthrough doors where shown. These doors shall have a minimum clear width of 18 inches. Provide doors with 8 inch square double pane wire glass windows. Locate windows not to exceed 5 feet-6 inches to centerline above finished floor of installed casing. Walk-through doors shall be operable from both sides of the door.

D. Access doors shall be insulated same as duct.

E. Provide with continuous neoprene gaskets around perimeter of access doors for airtight seal.

F. Provide all access doors with cam lock latches.

G. Provide access doors with watertight gaskets in shower room exhaust ductwork. Doors shall be of extra-heavy stainless construction.

H. All access doors serving a fire damper shall be painted red and shall have a label with white letters not less than ½ inch high reading "FIRE DAMPER". No external ductwork insulation shall conceal a fire damper access door unless there is a label attached to the insulation indicating the exact location of the access door.

I. Provide access doors in following locations:
   1. Automatic dampers: linkage side.
   2. Fire damper, on both sides of ducts.
   3. Smoke detection heads.
   4. On both sides of ducts where necessary to provide maintenance accessibility to equipment on either side.
   5. Heating and Cooling coils.
   6. Fan Plenums.
   7. In-Line Fans (suction and discharge sides)
   8. Other items requiring access for service/maintenance

J. Where duct access doors are concealed the Contractor shall furnish and pay for installation of access doors to be mounted in the fire rated walls and ductwork enclosures. The access doors must be fire resistive and minimum 6" larger on each side then the duct access door for the above mentioned applications.

2.04 MANUAL VOLUME DAMPER

A. Fabricate in accordance with SMACNA Duct Construction Standards Metal And Flexible, and as indicated.

B. Fabricate single blade dampers for duct sizes up to 6 inches in height.

C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes of 4 inches for ducts above 6 inches in height. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

E. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30 inches, provide regulator at both ends.

F. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

G. Volume damper shall be provided at each duct branch and also where shown on the Drawings. Volume dampers must be installed at each branch even if they are not shown on the Drawing.

H. Approved Manufacturers:
   1. Ruskin Mfr. Co.
   2. Arrow Damper & Louver.

3. Imperial Damper Co.

2.05 MOTORIZED DAMPERS

A. Motorized dampers for use with exterior louvers are covered in Section 10200 - HVAC Louvers.

2.06 DUCT TEST HOLES

A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.07 SEALANTS

A. Where ducts are not continuously welded or soldered, provide sealants and gaskets as required to meet the specified duct leakage allowance.

B. Provide Gaskets, Sealers, Mastics and Tapes as manufactured by Ductmate or approved equal.

2.08 FIRE DAMPERS

A. Fabricate and install in accordance with NFPA 90A and UL Safety Standard 555, and AMCA Standard 500.

B. Fire Resistance: For penetrations through construction rated less than 3 hours, 1 ½ hours. For penetrations through construction rated for 3 hours or more, 3 hours.

C. Pressure Differential Rating: 4 in. w. g.

D. Velocity Rating: 2000 fpm

E. Fabricate curtain type dampers of galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades in air stream. Fabricate fire dampers for vertical and horizontal position.

F. Fabricate multiple blade fire dampers with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

G. Fusible links, UL 33, shall separate at 165 degrees F.

H. Acceptable Manufacturers:
   1. Greenheck Model DFD 150, 200 and 350
   2. Ruskin Mfr. Co.

3. Arrow Damper & Louver.
4. Imperial Damper Co.

2.09 ALUMINUM DUCTWORK

A. Construct ducts of minimum No. 20 gauge aluminum sheet meeting ASTM B209, Series 3000 Alloy.

B. Construct ductwork as per "GALVANIZED STEEL RECTANGULAR DUCTS AND FITTINGS" section above unless otherwise noted in this section.

2.10 STANDARD FLEXIBLE CONNECTIONS

A. Provide fabric flexible duct connections.

B. Fabric shall be UL approved, fire-retardant, closely-woven glass, double coated with neoprene, and a minimum of 4 inches wide.

C. Shall be installed at duct connections to all ceiling hung fans, where vibration will be transmitted through ductwork, and as called for on the Drawings and HVAC Details.

D. Approved Manufacturers:
1. Ventglas" by Vent Fabrics, Inc. or approved equal.

E. Flexible connectors for use with the Process Blowers shall be provided by the Blower Vendor and specified elsewhere.

2.11 GALVANIZED STEEL ROUND DUCTS AND FITTINGS

A. Construct ducts of galvanized sheet steel meeting ASTM A 653 with G90 coating designation, and in accordance with the latest SMACNA HVAC Duct Construction Standards Metal and Flexible (Latest Edition).and pressure classifications as stated on the Drawings (minimum 2" w.c. pressure classification). When the ductwork pressure classification of these standards is exceeded, construct galvanized steel round exhaust ductwork in accordance with SMACNA Round Industrial Duct Construction Standards.

B. For ductwork through 60 inches in diameter, provide ducts of spiral lock-seam construction.

C. For ductwork over 60 inches in diameter, provide ducts of welded longitudinal seam construction.

D. For ductwork through 36 inches in diameter, use beaded sleeve transverse joints.

E. For ductwork over 36 inches in diameter, use gasketed-flanged Van Stone transverse joints. Gasket shall be "440 Gasket Tape" by Ductmate Industries, Inc.

F. For ductwork under a positive pressure through 96 in. diameter and 10 in. w. g. no reinforcing is required. For ductwork under a negative pressure in exposed areas use

duct gauge that will minimize the use of reinforcing as appropriate for the pressures involved.

G. Draw band joints will not be permitted.

H. All elbows shall be constructed with a centerline radius equal to 1.5 times the duct diameter.

I. Provide matching galvanized steel fittings with continuously welded seams and joints.

J. All take-off connections to duct headers shall be made using tee (90 degrees), lateral (45 degrees), tee cross, lateral cross and "Y" branch fittings of the conical type. All fittings fabricated as separate fittings shall have continuous welds along all seams and joints.

K. The use of two-piece mitered, vaned elbows will be permitted only with specific written approval from the Engineer. Provide turning vanes as per SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.12 TRANSITIONAL SILENCERS

A. Silencers shall consist of flanged sheet metal housing for connection in-line with ductwork system. The housing material shall match the specified ductwork material for the given airflow system.

B. The sound absorbing fill material shall be acoustic grade glass fiber protected by perforated metal.

C. Silencers shall transition in size between the inlet and oulet ductwork connection; sizes shall be as called for on the Drawings.

D. Manufacturer shall calculate and provide the pressure drop at the design flow rate including pressure drop from system effects due to nearby duct elements. Pressure drop shall be determined as per ASTM E477-20. Maximum pressure drop at the design flow rate shall be as called for on the Drawings.

E. Dynamic insertion loss (dB) values shall be determined as per E477-20. Minimum performance shall be as follows:

Octave Band (Hz)	63	125	250	500	1000	2000	4000	8000
Dynamic Insertion Loss (dB)	2	5	11	17	31	38	25	19

F. Transitional silencers shall be type T-RD by Vibro Acoustics. Alternate manufacturers, subject to submittal review to meet performance requirements, include Price Industries or Engineer approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. Install ductwork in accordance with applicable SMACNA Duct Construction Standards Metal And Flexible and approved submittals, and as shown on the Drawings. Duct sizes shown are inside clear dimensions. Where internal duct liners are used, duct sizes shown are inside clear of liner. For ductwork located outside, provide reinforcing sufficient to support wind and snow loads.

B. The Drawings indicate general locations of ducts. Make additional offsets or changes in direction as required at no additional cost to the Owner.

C. Wherever ductwork is divided, maintain the cross-sectional area.

D. Do not exceed 15-degree taper when constructing duct transitions.

E. Close the open ends of ducts during construction to prevent debris and dirt from entering.

F. Secure casings and plenums to curbs according to the requirements of the SMACNA HVAC Duct Construction Standards Metal and Flexible.

G. Make changes in direction with long radius bends.

H. All welded and scratched galvanized steel surfaces shall be touched up with zinc-rich paint.

I. 2 Hr. rated wall penetration: Where small size duct (up to 6 inches x 6 inches) is penetrating a 2 Hr wall the duct shall be constructed of 16 gauge galvanized sheet metal.

J. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

K. Patch and repair all wall penetrations.

L. Insulation: Where Drawings and Specifications indicate that ducts are to be insulated make provisions for neat insulation finish around damper operating quadrants, splitter adjusting clamps, access doors, and similar operating devices. Metal collar equivalent in depth to insulation thickness and of suitable size to which insulation may be finished to be mounted on duct.

3.02 FITTING INSTALLATION

A. Use minimum of four sheet metal screws per joint.

B. Apply approved sealant on duct-to-duct joint before assembly. Apply additional sealant after assembly to make joint airtight.

3.03 HANGER AND SUPPORT INSTALLATION

A. Hang and support ductwork in accordance with SMACNA HVAC Duct Construction Standards and Section 15060 - Hangers and Supports for HVAC Systems.

B. Do not support ductwork from furring, hung ceilings, metal floor deck, metal roof deck or from another duct or pipe.

C. Do not hang lighting fixtures or piping from ductwork.

D. Do not use perforated band iron.

E. Support ductwork at each change in direction.

F. Where duct connects to or terminates at masonry openings or at floors where concrete curbs are not used, provide a continuous 1 ½ inch by 1 ½ inch by 3/16 inch galvanized steel angle support around the ductwork. Bolt and seal the supports to the building construction using expansion bolts and caulking compound. Seal shall be watertight at floor or wall and duct such that a spill will no pass down through the opening.

G. For insulated ductwork, install hangers on the outside of the insulation. To maintain the insulation value, inset a piece of 1 inch thick, 6 pcf fiberglass board with a foil/scrim/kraft (FSK) jacket at these supports.

3.04 SEALING

A. Where ductwork is not continuously welded, soldered or gasketed, make seams and joints airtight with sealants.

B. Install the sealants in accordance with the sealant manufacturer's instructions and recommendations.

C. Seal all ductwork seams, joints, fastener penetrations and fittings connections with sealants in accordance with SMACNA Seal Classifications as required by SMACNA Duct Pressure Classification. All ductwork, regardless of pressure classification, shall have a minimum Seal Class B.

D. Completely fill all voids when liquid sealing ductwork. Several applications may be necessary to fill voids caused by shrinkage or runout of sealant.

3.05 DUCT-MOUNTED DEVICES AND ACCESS DOORS

A. Install all dampers and other duct-mounted devices, specified in this or other sections, in accordance with manufacturer's instructions. Provide all transitions as required.

B. Install access doors in ductwork, plenums and where specified and as shown. Provide access doors for inspection and cleaning automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 18 x 18 inch size for shoulder access and as indicated. Install access doors in the bottom of the ductwork unless they are

inaccessible in this location; then install the access doors in either the side or top of the ductwork, whichever is more accessible.

C. Provide fire damper at locations indicated, and where outlets pass through fire rated components and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway, duct connections, corrosion resistant springs, bearings, bushings and hinges.

D. Demonstrate re-setting of fire dampers to authorities having jurisdiction and Engineer.

E. Provide flexible connections immediately adjacent to equipment in ducts associated with motorized equipment. Cover connections to medium pressure fans with leaded vinyl sheet, held in place with metal straps.

F. Pilot Ports: Locate pilot ports for measuring airflow in each main supply duct at the downstream end of the straightest run of the main and before the first branch take-off. Form pilot ports by drilling 7/16 inches holes in the duct, lined up perpendicular to airflow on maximum 8-inch centers and at least three to a duct, evenly spaced. Holes to be plugged with plastic plugs. Provide access to these for future rebalancing.

3.06 DUCTWORK AND EQUIPMENT LEAK TESTING

A. Leak test each ductwork system within ten working days of ductwork installation and before ductwork is insulated and concealed.

B. All HVAC ductwork shall be tested. Follow general procedures and use apparatus as outlined in the SMACNA HVAC Air Duct Leakage Test Manual.

C. Test all ductwork at 100 percent of the pressure classifications indicated.

D. Air testing during erection shall include separate leakage air tests of air riser, horizontal distribution system, and, after all ductwork is installed and the central stations apparatus is erected, leakage testing of the whole system.

E. Use Appendix C in the SMACNA HVAC Air Duct Leakage Test Manual to determine allowable leakage rates for each duct section tested.

F. All devices, including access doors, airflow measuring devices, sound attenuators, damper casings, sensors, test ports, etc. that are furnished and/or installed in duct systems shall be included as part of the duct system leakage allowance. All joints shall be inspected and checked for audible leakage, repaired, if necessary, and retested. Duct leakage shall be limited to the following:

Average Size of Run Diameter or Equivalent	***A/100 ft. Run**
12 inches or less	10
20 inches or less	15
30 inches or less	25

Average Size of Run Diameter or Equivalent	*A/100 ft. Run
40 inches or less	30
50 inches or less	30
* (A) = Permissible loss in cfm	

G. Total system leakage shall not exceed 10 percent of the scheduled design capacity of the system when tested as per SMACNA testing methods.

3.07 DUCTWORK MATERIAL SCHEDULE

AIR SYSTEM	DUCTWORK MATERIAL
HVAC Supply and Exhaust Ductwork	Min. 22 ga Galvanized Steel
Blower Intake Ductwork	Min. 16 ga Galvanized Steel
Battery Room Exhaust Ductwork	Min. 20 ga Aluminum

+ + END OF SECTION + +

SECTION 15830

EXHAUST FANS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Provide exhaust fans, as specified herein, of sizes and capacities scheduled and in locations shown on drawings.

1.02 REFERENCE CODES AND STANDARDS

A. AMCA 99 - Standards Handbook

B. AMCA 210 - Laboratory Methods of Testing Fans for Rating

C. AMCA 300 - Reverberant Room Method for Sound Testing of Fans

D. ASHRAE Handbook, HVAC Applications Volume "Sound and Vibration Control"

E. UL listed and labeled.

1.03 SUBMITTALS

A. Shop Drawings - Show fan layout, housing, materials, gauges, dimensions, weights and installation details

B. Product data - Manufacturer's fan performance (data includes cfm, rpm, bhp, motor nameplate data, tip speed, outlet velocity and static pressure) and sound performance (data includes sound power level ratings by octave bands) as tested in accordance with AMCA Standards 210 and 300.

C. Fan performance curves - Submit curves for all fans with system performance shown, and for plus or minus 10 percent and plus or minus 20 percent change in fan rpm. Curves shall include plotted rpm, horsepower, cfm, static pressure, and fan surge line and operating point.

D. Exhaust fan supports delegated design and shop drawing - Submit shop drawing for ancillary steel support design for the hanging of the exhaust fans as shown in the exhaust fan hanging detail on the Drawings. Shop drawing shall indicate the proposed fastening methods of ancillary steel members to the building structure, method of fastening fan hanger rods to the steel, and member and hardware sizes. The shop drawings shall be stamped by a professional engineer.

E. Certified AMCA Ratings - Submit ratings for air and sound performance.

F. UL Listing - Submit listing if specified.

1.04 QUALITY ASSURANCE

A. Factory balance each fan statically and dynamically, test run before shipment, and key fan wheel to fan shaft. Fans shall operate quietly and without pulsation or vibration. Conduct sound power level tests for each type fan at the factory in accordance with AMCA 300.

B. Fans shall operate in the stable range of their performance curves.

C. The fan external static pressures shown in the schedules are those required by the ductwork and apparatus, and do not include the internal and intake fan losses, inlet vanes, outlet velocity heads, or drive losses. Additional pressures should be added/accounted for by fan vendor.

D. Factory performance test each fan assembled in or as part of apparatus specified to be performance tested. Test shall display scheduled performance characteristics, using certified, calibrated testing instruments provided by the manufacturer of the apparatus.

E. All fan performance ratings shall be based up on factory tests performed in accordance with AMCA 210. One fan of each type specified shall have actual factory performance tests performed prior to shipment. All fans shall be certified by AMCA and carry its seal.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable exhaust fan manufacturers include:
   1. Hartzell Air Movement
   2. New York Blower Co
   3. Twin City Fan and Blower

2.02 BELT DRIVE DUCT FANS

A. General Description:
   1. Belt Drive inline axial fans shall be manufactured by Hartzell Air Movement, Series 31, or approved equal.
   2. Fan arrangement shall be as shown on the Drawings.
   3. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

B. Propeller:
   1. The utility duct fan propeller shall be an airfoil design, cast of 319 aluminum in compliance with Federal Specification QQ-A-601E and ASTM B26. Propellers shall be retained on the fan shaft utilizing a split taper bushing.

C. Fan Housing:

1. Housing shall have self-formed flanges with slotted mounting holes.
2. Fan housing shall be minimum 12 gauge rolled commercial quality carbon steel, continuously welded in compliance with AWS D1.1 standard, unless alternate material is called for on the schedules.
3. Standard coating shall be industrial grade air dry enamel paint, unless special coating is called for on the schedules.
4. Fan construction shall be capable of 200°F operatiion.

D. Motor:
1. The motor shall be mounted on a continuously welded motor base.
2. The motor mounting base shall be adjustable to permit belt tensioning by adjustment of the motor position.
3. Motor enclosure shall be as called for on the equipment schedules.

E. Shaft:
1. Fan shafts shall be stainless steel with Teflon shaft seal.

F. Bearings/Belts:
1. Bearings shall be located in a drive compartment on the negative pressure side of the propeller, drawing outside ambient air in and over the belts and bearings.
2. Bearings shall be heavy duty, self-aligning, ball or roller type and shall have extended lube tubes for relubrication for continuous service and have minimum L-10 life of 50,000 hours.
3. Variable pitch drive sheaves shall be standard.
4. Belts shall be heat, oil and static resistant, "V" type, and sized for continuous service.

G. Fan Assembly:
1. The fan assembly shall be dynamically balanced at the factory prior to shipping.
2. Fans shall be balanced to the American National Standards Institute, Std. S2.19-1989 “Balance Quality of Rotating Rigid Bodies”, and Grade G6.3.
3. Fan performance shall be based on tests conducted in an AMCA accredited test laboratory and in accordance with the latest revision of AMCA Standard 210 for air performance and AMCA Standard 300 for sound. Fans shall be licensed to bear the AMCA Certified Sound and Air Performance Rating Seal.

H. Options/Accessories:
1. All options and accessories shall be as called for on the equipment schedules.

2.03 DIRECT DRIVE DUCT FANS

A. General Description:
1. Direct drive inline vaneaxial fan shall be manufactured by Hartzell Air Movement, series 65C, or approved equal.
2. Fan arrangement shall be as shown on the Drawings.
3. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

B. Propeller:
   1. The duct fan propeller shall be an airfoil design, multiple bladed, cast of 319 aluminum in compliance with Federal Specification QQ-A-601E and ASTM B26.
   2. Propellers shall be retained on the motor shaft utilizing a split taper bushing.

C. Motor:
   1. Rigid motor mounts shall provide support for the motor.
   2. Motors shall be totally enclosed air over type, unless otherwise called for on the schedules.
   3. All fractional motors shall be permanently lubricated, non-regreasable.
   4. Integral horsepower motors shall be supplied with regreasable bearings and extended lubrication tubes and grease fittings.
   5. Fans shall be designed for mounting in any position from horizontal to vertical.
   6. The fan shall be capable of being used in temperatures up to 104°F.

D. Fan Housing:
   1. Housing shall have rolled flanges continuously welded to the drum. Flanges shall have slotted mounting holes.
   2. Fan housings shall be minimum 12 gauge rolled commercial quality, carbon steel and continuously welded in compliance with AWS D1.1 standards, unless alternate material is called for on the schedules.
   3. Standard surface coating system shall be industrial grade air dry enamel paint, unless specialty coating is called for on schedules.

E. Fan Assembly:
   1. The fan assembly shall be dynamically balanced at the factory prior to shipping.
   2. Fans shall be balanced to the American National Standards Institute, Std. S2.19-1989 “Balance Quality of Rotating Rigid Bodies”, and Grade G6.3.
   3. Fans shall be manufactured in accordance with manufacturer's standard quality assurance procedures. Fan performance shall be based on tests conducted in an AMCA accredited test laboratory and in accordance with the latest revision of AMCA Standard 210 for air performance and AMCA Standard 300 for sound. Fans shall be licensed to bear the AMCA Certified Sound and Air Performance Rating Seal.

F. Options/Accessories:
   1. All options and accessories shall be as called for on the equipment schedules.

PART 3 - EXECUTION

3.01 GENERAL

A. Install fans, including all necessary structural supports, vibration isolators, and bracing, as scheduled and located on the contract drawings and in accordance with manufacturer’s instructions and approved submittals.

B. Connect duct to fans to allow for straight and smooth air flow.

C. Provide flexible connections (minimum of 4”) between fan and duct.

D. Install fan level: +/- 5 degrees vertical. Final installation shall be free of all leaks from both fan and associated ductwork.

3.02 START-UP, TESTING, DEMONSTRATION

A. Start-up fans after checkout to ensure proper alignment and phased electrical connections.

B. Test fans individually and as part of system.

C. Ensure fans are properly interlocked with control system.

D. Demonstrate operation to Owner and instruct maintenance personnel in operation of equipment.

+ + END OF SECTION + +

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SECTION 15850

DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This Section describes the air terminals as specified herein, with capacities, distribution patterns and connection sizes as scheduled on the Drawings.

B. Products listed in Part 2 of this Section include:
   1. Grilles and Registers.
   2. Ceiling Diffusers.

1.02 RELATED WORK

A. Section 15810: Sheet Metal Work for HVAC Systems

1.03 REFERENCES

A. ADC 1062 GRD - Test Code for Grilles, Registers and Diffusers

B. ASHRAE 70 - Method of Testing for Rating the Airflow Performance of Outlets and Inlets.

C. ASHRAE 113 - Method of Testing Room Air Diffusion

D. ASTM C423 - Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

E. ARI 880 - Air Terminals

F. ARI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

G. NFPA 90A - Installation of Air Conditioning and Ventilation Systems

H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

I. Mechanical Code of New York State

1.04 QUALITY ASSURANCE

A. Air Terminals will not be accepted until acoustical test results have been submitted and approved.

1.05 SUBMITTALS

A. Product data - Submit catalog cuts and installation instructions for all products specified, including standard color samples.

B. Submit published manufacturer's performance data for all of the different types of diffusers, registers and grilles, based on testing in accordance with ASHRAE Standard 70, latest edition.

C. Performance data - For each size and type of air terminal , submit the following:
   1. Inlet static pressure in inches w.g.
   2. Maximum and minimum airflow in cfm.
   3. Throw in feet at maximum cfm (and 25 percent of cfm) for terminal velocities of 50 and 100 fpm.
   4. Noise Criteria (NC) curve at maximum air terminal cfm rating with blades in full-open and closed positions.

PART 2 - PRODUCTS

2.01 ARCHITECTURAL CEILING DIFFUSERS:

A. Furnish and install architectural ceiling diffusers of the sizes and capacities as shown on the Drawings.

B. Manufacture the diffuser from corrosion-resistant steel or extruded aluminum as indicated on the Drawings.

C. Construct the units of a stamped outer core and with the inner core having a plaque style face. Construct the face with a double skinned inner face panel with a hemmed edge. Manufacture the inner core assembly to be removable using a spring clip arrangement that permits quick, easy installation and removal.

D. Manufacture diffusers with trim to allow for with face panel flush with the ceiling line into ceiling grids or for surface mount in other ceiling types.

E. Provide an opposed blade radial volume damper, with an operating arm to adjust the damper without removing the core. Unit collar height; 1 ¼" in height.

F. Provide an equalizing grid for field installation for each diffuser.

G. Provide backing insulation.

H. Manufacturer: Nailor Industries Inc., Model Series UNI or approved equal.

I. Coordinate color with Owner.

2.02 RETURN GRILLES

A. Furnish and install return grilles of the type and size as shown on the Drawings. Construct the grilles with 45 degree deflection fixed blades and frames that have reinforced mitered corners.

B. Provide an opposed blade damper operable from the face of the grille.

C. Manufacture grilles with trim to allow for recessed mounting into ceiling grids or for surface mount in other ceiling types or directly on ductwork. Provide concealed mounting using concealed mounting straps or concealed screw holes in neck. Countersunk screw holes in the frame face are not acceptable or frame face-mounting screws.

D. Units shall be constructed of steel.

E. Manufacturer: Nailor Industries Inc, Model Series 6145H-O, or approved equal.

F. Coordinate color with Owner.

2.03 SUPPLY GRILLES

A. Furnish and install supply grilles of the type and size as shown on the Drawings. Construct the grilles with a dual set of streamlined shaped, roll-formed, corrosion-resistant blades that are adjustable, and spaced on ¾" centers and frame with reinforced mitered corners.

B. Manufacture grilles with trim to allow for recessed mounting into ceiling grids or for surface mount in other ceiling types or directly on ductwork. Provide concealed mounting using concealed mounting straps or concealed screw holes in neck. Countersunk screw holes in the frame face are not acceptable nor are frame face-mounting screws.

C. Construct the units of corrosion resistant steel.

D. Grilles shall include opposed blade damper operable from the face of the grille.

E. Manufacturer: Nailor Industries Inc., Model Series 61DH-O or approved equal.

F. Coordinate color with Owner.

PART 3 - EXECUTION

3.01 DIFFUSER, REGISTER AND GRILLE APPLICATION

A. See the Drawings for types, sizes, materials and installation requirements.

3.02 INSTALLATION

A. Install diffusers, grilles and registers in locations shown on the Drawings.

B. Consult the Drawings for type of ceiling in which the terminals are to be installed and match air outlet edge trim to the requirements of the ceiling type in which they are installed.

C. Install equalizing grids flush with take-off collar connection to supply duct with vanes perpendicular to air flow approaching diffuser.

D. Install in accordance with manufacturer's published recommendations as well as applicable sections of SMACNA manual and as specified above.

E. Install ceiling mounted grilles and registers with the blade deflection facing away from the line of sight.

F. Ductwork insulation, as required per insulation schedule, shall be continuous from supply duct mains, flex ducts (if applicable), up to, and sealed with supply diffuser molded insulation blanket with continuous vapor barrier, regardless of ceiling plenum condition.

G. Coordinate with other work, including ductwork and ductwork accessories, as necessary to interface installation of air outlets and inlets with other work

+ + END OF SECTION + +

SECTION 15905

INSTRUMENTATION AND CONTROL INTEGRATION FOR HVAC SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The work specified as part of this Section consists of the integration of equipment controls supplied as part of manufactured items, materials and equipment required by the Drawings and under Divisions 15 and 16 to achieve operational and coordinated Sequences of Operation as Specified. Work shall include management of the system start up and operational check out, coordination of functions of controllers supplied as part of equipment packages, sizing of control valves and damper operators for dampers, interconnection of systems, provision and installation of all accessory devices required for complete system operation including dampers, control valves and actuators not provided as part of equipment, coordination of start up and testing and demonstration of the operation of Sequences of Operation to the Owner and the Owner's representatives.

1.02 RELATED SECTIONS

A. The General Conditions of the Contract and General Requirements are a part of these Specifications and shall be used in conjunction with this Section as a part of the Contract Documents. Consult them for further instructions pertaining to this work. The Contractor is bound by the provisions of Division 00 and Division 01.

B. The following Sections constitute related work:
   1. Section 15940 - Sequence of Operations for HVAC Systems
   2. Equipment and Systems specified under Division 15
   3. Division 16

1.03 QUALITY ASSURANCE

A. System Installer Qualifications
   1. The Integrator shall have a minimum of five years experience in the integration of systems of a similar nature to those of this Project.
   2. The Integrator shall have an office within 50 miles of the project site and provide 24-hour response in the event of a customer call.

B. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.
   1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.
   2. National Electrical Code - NFPA 70.

C. All products used in this installation shall be new, currently under manufacture, and shall have been applied in similar installations for a minimum of 2 years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date. Spare parts shall be available for at least 5 years after completion of this Contract.

1.04 SUBMITTALS

A. Submit at the time of bid the name and qualifications of the firm that will be responsible for the Integration function along with the qualifications of the specific personnel proposed. The Owner and Engineer may choose to interview the personnel proposed for the project.

B. Contractor shall provide shop drawings and manufacturer's standard specification data sheets on all materials and hardware to be provided. No work may begin on any segment of this project until the Engineer and Owner have reviewed submittals for conformity with the Drawings and Specifications. All shop drawings shall be provided to the Owner electronically as .dwg or .dxf file formats.

C. Submit a written sequence of operation for each system indicating which functions are to be controlled by controls provided as part of manufactured equipment and which functions will be under control of devices provided as part of this Section.

D. Submit interconnecting wiring diagrams for all systems. These diagrams may rely on diagrams for controls of manufactured equipment provided that the interface points are clearly identified and copies of the manufactured item's control diagrams are submitted for information as part of the submittal package.

E. Submit any additional information or data which is deemed necessary to determine compliance with these specifications or which is deemed valuable in documenting the system to be installed.

F. Submit the following within 30 days of contract award:
   1. A work plan and schedule for the start up and check out of all systems including time requirements and resources required from all Sub-Contractors involved.
   2. A complete list of equipment to be used indicating quantity, manufacturer and model number.
   3. A schedule of all control valves including the valve size, model number (including pattern and connections), flow, CV, pressure rating, and location.
   4. A schedule of all control dampers. This shall include the damper size, pressure drop, manufacturer and model number.
   5. Provide manufacturer's cut sheets for major system components. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is being submitted to cover.

6. The submittals required under this Section shall be considered as For Information Only. Review by the Engineer shall not relieve the Contractor from the responsibility of providing fully operational systems.

1.05 WARRANTY

A. Warrant all work as follows:
   1. Labor & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. The Contractor shall respond to the Owner's request for warranty service within 24 hours during customary business hours.
   2. At the end of the final start-up/testing, if equipment and systems are operating in a manner satisfactory to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this Specification. The date of Owner's acceptance shall be the start of warranty.

PART 2 - PRODUCTS

2.01 STANDARD OF QUALITY AND PERFORMANCE

A. Products specified are not intended to form a complete scope of supply. They are intended to set a level of quality for items that the Contractor may need to supply to implement a complete Sequence of Operation. Products of a comparable quality and performance may be submitted for approval by the Engineer.

2.02 CONTROL WIRING CONDUIT

A. Control wiring conduit shall be in accordance with Section 16131 - Electric Conduit System.

2.03 MOTORIZED DAMPERS

A. Motorized dampers for use with exterior louvers are covered in Section 10200 - HVAC Louvers.

2.04 MOTORIZED DAMPER WHISKER (PROOF) SWITCHES

A. Whisker switches shall be used to prove that damper blades are open, where called for on the Drawings.

B. Whisker switches shall be multi-directional contact switch with plastic coated spring rod whisker.

C. Whisker switches shall have screw wiring terminals and threaded conduit connection.

D. Operating temperature range shall be -13° to 131°F.

E. Switch shall have 1 N.O. and 1 N.C. contact, rated for 10A at 120 VAC or 24 VAC, and rated for 6A at 24 VDC.

F. Enclosure rating shall be IP67.

G. Whisker switches shall be by Kele or equivalent.

2.05 CONTROL VALVES

A. Motorized on/off two-way control valves for use with the Blower Oil-to-Water Coolers shall be provided by the Blower Vendor and controlled via the Blower controls. Valve size shall be as called for on the HVAC Drawings.

B. Motorized on/off two-way control valves for use with the Air-to-Water Heat Pumps shall be provided by the Air-to-Water Heat Pump Vendor and controlled via the Air-to-Water Heat Pump controls. Valve size shall be as called for on the HVAC Drawings.

2.06 TEMPERATURE SENSORS

A. Temperature sensors for use with the Air-to-Water Heat Pumps shall be provided by the Air-to-Water Heat Pump Vendor.

B. Temperature sensors for use with the Water-to-Water Heat Pumps shall be provided by the Water-to-Water Heat Pump Vendor.

2.07 THERMOSTATS

A. Thermostats for use with the variable refrigerant flow (VRF) split systems shall be provided by the VRF system manufacturer.

B. Thermostats for use with the electrical room air conditioners (ERAC) shall be provided by the ERAC manufacturer.

C. Thermostats for integration with hydronic control panel (HCP-1) for control of the hydronic unit heaters shall be as follows:
   1. Thermostats shall be mechanical thermostats, NEMA-4X construction.
   2. Sensing element shall be stainless steel coil.
   3. Switching action shall be SPDT.
   4. Contact rating for 120V shall be minimum 16A FLA, 25A non-inductive. Contact rating for 277V shall be minimum 10A FLA, 22A non-inductive. Contacts shall be suitable for use at 24V.
   5. Thermostats shall have large visible dial with temperature range 40°F to 110°F with fixed 3°F differential.
   6. Thermostats shall be model TF115-001 by PECO Industrial Controls.

D. Thermostats for integration with exhaust fan control panel (EFCP-1) for control of the exhaust fans and motorized dampers shall be as follows:
   1. Thermostats shall be mechanical thermostats, NEMA-4X construction.
   2. Sensing element shall be stainless steel coil.

3. Switching action shall be SPDT.
4. Contact rating for 120V shall be minimum 16A FLA, 25A non-inductive. Contact rating for 277V shall be minimum 10A FLA, 22A non-inductive. Contacts shall be suitable for use at 24V.
5. Thermostats shall have large visible dial with temperature range -30°F to 100°F with fixed 6°F differential.
6. Thermostats shall be model TF115-023 by PECO Industrial Controls.

2.08 AQUASTATS

A. Aquastats shall have liquid filled copper sensing bulbs.

B. Aquastats shall have screw wiring terminals.

C. Contact ratings shall be as required for connected devices.

D. Provide thermowells for mounting in pipe or tanks as required.

E. Aquastats shall be L-4000 - L-6000 Series Aquastat Controllers by Honeywell or approved equal, exact model shall be determined for required switching action, setpoint range, and differential as required by the Sequence of Operations.

2.09 FLOW SWITCHES

A. Flow switches shall be dual temperature sensor probe type sensor for flow/no-flow switching.

B. Flow switches shall have no moving parts.

C. Set Point range shall be:
   1. 0.02 - 0.8 feet per second for liquids
   2. 0.5 - 140 feet per second for air/gas

D. Flow switch enclosures shall be explosion proof.

E. Sensor head shall be type 316L Stainless Steel capable of operating to 4000 PSIG and in temperature range of -50 to 350°F.

F. Voltage shall be 120V, 24V, or 12V based on specific application shown on the Drawings and Diagrams.

G. Flow switches shall be FX Series by Ameritrol, Inc. or equivalent.

2.10 RELAYS

A. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.

B. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application.

C. Relays shall not be mounted exposed. All relays shall be located within control panels.

2.11 TRANSFORMERS AND POWER SUPPLIES

A. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.

B. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.

C. Unit shall operate between 0 degrees C and 50 degrees C.

D. Unit shall be UL recognized.

E. Transformers and power supplies shall not be mounted exposed. All transformers and power supplies shall be located within control panels.

2.12 LOCAL CONTROL PANELS

A. All control cabinets shall be fully enclosed NEMA-1 rating. Where located outdoors, panels shall be NEMA-4X. Provide cabinet with hinged door, key-lock latch, and removable sub-panels. A single key shall be common to all field panels and sub-panels.

B. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

C. Provide on/off power switch with over-current protection and main air gauge for control power sources to each local panel.

PART 3 - EXECUTION

3.01 GENERAL WORKMANSHIP

A. Install equipment, piping, wiring/conduit parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install all equipment in readily accessible location as defined by Chapter 1 Article 100 part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.02 WIRING

A. All control and interlock wiring shall comply with the national and local electrical codes and Division 16 of these Specifications. Where the requirements of this Section differ with those in Division 16, the requirements of this Section shall take precedence.

B. Do not install Class 2 wiring in conduit containing Class 1 wiring. Do not use boxes and panels containing high voltage for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

C. All control wiring shall be installed in conduit.

D. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to wire connections shall be at a terminal blocks, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

E. Maximum allowable voltage for control wiring shall be 120V. Provide and install step down transformers as required.

F. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

G. Maintain fire rating at all penetrations in accordance with other Sections of this Specification and local codes.

H. Size of conduit and size and type of wire shall be the design responsibility of the Contractor, in keeping with the manufacturer's recommendations and the NEC.

I. Locate control and status relays in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.

J. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.

K. Adhere to Division 16 requirements for installation of raceway.

L. Maintain an updated (as-built) wiring diagram with terminations identified at the job site.

M. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3 feet in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture liquid tight, flexible metal conduits shall be used.

3.03 INSTALLATION OF SENSORS AND THERMOSTATS

A. Install sensors and thermostats in accordance with the manufacturer's recommendations and the Contract Drawings.

B. Mount sensors and thermostats rigidly and adequate for the environment within which the sensor or thermostat operates.

C. All pipe and tank mounted temperature sensors shall be installed in wells.

D. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

3.04 FLOW SWITCH INSTALLATION

A. Install in accordance with manufacturers' instructions.

B. Assure correct flow direction and alignment.

3.05 WARNING LABELS

A. Affix plastic labels on each starter and equipment automatically controlled. Label shall indicate the following:

C A U T I O N This equipment is operating under automatic control and may start at any time without warning.

3.06 IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2 inches of termination with a cable identifier and other descriptive information.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 1-cm letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

3.07 CLEANING

A. The Contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.

C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.08 PROTECTION

A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.09 FIELD QUALITY CONTROL

A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.

C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

3.10 ACCEPTANCE

A. The control systems will not be accepted as meeting the requirements of completion until all tests described in this Specification have been performed to the satisfaction of both the Engineer and Owner.

B. The full range of operation for all Sequences of Operation shall be demonstrated. Where sequences are dependent on season or outside conditions these conditions may be simulated for the purpose of demonstration if approved by both the Engineer and the Owner. If simulations cannot be acceptably created the Contractor shall perform the demonstration during the proper period.

C. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's representative. Such tests shall then be performed as part of the warranty.

+ + END OF SECTION + +

SECTION 15940

SEQUENCE OF OPERATIONS FOR HVAC SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The Work specified as part of this Section consists of the work required to achieve operational and coordinated Sequences of Operation as described. Work includes coordination of functions of controllers supplied as part of equipment packages, interconnection of systems, provision and installation of all accessory devices required for complete system operation including devices not provided as part of equipment, coordination of start up and testing and demonstration of the operation of Sequences of Operation to the Owner and the Owner's representatives.

B. The control system operation of all equipment shall be subject to the operational modes, conditions and logic described in this Section and the controlled equipment manufacturer's recommendations.

C. Training of the Owner's personnel in the operation, trouble shooting, adjustment and repair of all system controls.

1.02 RELATED SECTIONS AND WORK

A. HVAC Equipment Schedules, Floor Plans, Flow Diagrams, Details, and Control Diagrams

B. Section 15905 - Instrumentation and Control Integration for HVAC Systems

C. Division 16

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 GENERAL

A. An adjustable setpoint/parameter is abbreviated as (adj.).

3.02 SEQUENCE OF OPERATION - MOTORIZED INTAKE DAMPERS

A. General:
   1. This Sequence of Operation shall apply to the following equipment:
      a. MD-I1 thru MD-I48 (48 total motorized intake dampers).

2. One (1) motorized actuator shall be provided to serve two (2) dampers (24 total motorized actuators).
3. The motorized actuators shall be controlled by the Exhaust Fan Control Panel (EFCP-1). Refer to EFCP-1 Control Diagram.

B. Operation:
1. The motorized dampers shall open upon any of the following:
a. Activation of thermostat (TS-1), setpoint 74°F (adj.), OR;
b. Activation of any of the four (4) thermostats (TS-2, TS-3, TS-4, or TS-5) used to control the exhaust fans, setpoints as determined in the Exhaust Fans Sequence of Operation.
c. Any of the exhaust fans (EF-1 thru EF-5) are operating.

3.03 SEQUENCE OF OPERATION - MOTORIZED RELIEF DAMPERS (FIRST-STAGE-COOLING DAMPERS)

A. General:
1. This Sequence of Operation shall apply to the following equipment:
a. MD-R1 thru MD-R10 (10 total motorized relief dampers).
2. Each motorized damper shall be provided with a motorized actuator (10 total motorized actuators).
3. The motorized actuators shall be controlled by the Exhaust Fan Control Panel (EFCP-1). Refer to EFCP-1 Control Diagram.

B. Operation:
1. The motorized dampers shall open upon any of the following:
a. Activation of thermostat (TS-1), setpoint 74°F (adj.), OR;
b. Activation of thermostat (TS-6), setpoint 96°F (adj.).
2. The motorized dampers shall close upon any of the following:
a. De-activation of thermostats (TS-1 AND TS-6), OR;
b. Any of the exhaust fans (EF-1 thru EF-5) are operating.

3.04 SEQUENCE OF OPERATION - EXHAUST FANS

A. General:
1. This Sequence of Operation shall apply to the following equipment:
a. EF-1
b. EF-2
c. EF-3
d. EF-4
e. EF-5
2. Each exhaust fan shall be provided with an H-A (Hand-Auto) switch located on the Exhaust Fan Control Panel (EFCP-1). Refer to EFCP-1 Control Diagram.
3. Each exhaust fan shall be provided with a motor starter with auxiliary status output. The motor starter(s) shall receive enable signal from EFCP-1.
4. Each exhaust fan shall be provided with two (2) motorized dampers, two (2) motorized actuators, and two (2) whisker (damper proof) switches.

B. Fan Rotation:
   1. One (1) of the five (5) exhaust fans shall be selected as the standby fan by a manual selector switch located at EFCP-1.
      a. The standby fan shall be prevented from receiving enable signals.
   2. The position of the selector switch shall determine which of the four (4) duty fans is controlled by which of four (4) thermostats (TS-2, TS-3, TS-4, and TS-5).

C. Thermostats:
   1. The four (4) thermostats shall be located as shown on the Floor Plans and shall be set as follows:
      a. TS-2 - 80°F (adj.)
      b. TS-3 - 84°F (adj.)
      c. TS-4 - 88°F (adj.)
      d. TS-5 - 92°F (adj.)

D. Auto-Mode Operation:
   1. The control panel (EFCP-1) shall enable the four (4) duty exhaust fans in four (4) stages as each thermostat is activated and as per the exhaust fan rotation determined by the selector switch position.
   2. Upon being enabled, the exhaust fan's two (2) motorized dampers shall open.
   3. Upon both of the motorized dampers being proven open via the whisker switches, the fan shall be enabled to run.

E. Hand-Mode Operation:
   1. The hand-mode exhaust fan's two (2) motorized dampers shall open.
   2. Upon both of the motorized dampers being proven open via the whisker switches, the fan shall be enabled to run.

3.05 SEQUENCE OF OPERATION - PROCESS BLOWER COOLER PUMPS

A. General:
   1. This Sequence of Operation shall apply to the following equipment:
      a. P-1
      b. P-2
   2. The Pumps shall each be provided with a VFD capable of the following:
      a. Receiving remote enable signal
      b. Duty/standby programming for two pumps
      c. Programming/operation in constant speed, constant pressure, or manufacturer's quadratic control curve programming.

B. Pump Operation:
   1. The pumps shall be enabled to run continuously any time the building process is in operation.
   2. The pumps shall be programmed for duty/standby rotation.
      a. P-1 and P-2 shall not operate simultaneously.

3. The duty pump shall vary its speed as per the manufacturer's quadratic control curve programming to maintain relatively constant flow through each process blowers' oil-to-water cooler as the process blowers' motorized valves open/close.

C. Monitoring:
   1. An individual red LED in the piping near the blower cooler, and an individual control relay in the Hydronic Control Panel (HCP-1), shall be provided for the following for each process blower cooler as shown on the HVAC Details:
      a. Differential pressure across the heat exchager
      b. Heat exchanger outlet water tempreature

3.06 SEQUENCE OF OPERATION - AIR-TO-WATER HEAT PUMPS AND PUMPS

A. General:
   1. This Sequence of Operation shall apply to the following equipment:
      a. ATWHP-1
      b. ATWHP-2
      c. ATWHP-3
      d. Hydronic Pump - P-3
      e. Hydronic Pump - P-4
      f. Buffer Tank - BT-1
   2. The system shall be controlled by the Hydronic Control Panel (HCP-1). Refer to the HCP-1 Control Diagram.
   3. Buffer Tank (BT-1) temperature shall be monitored by the following temperature sensors/switches:
      a. Heating Stage 1 Aquastat (switch)
      b. Heating Stage 2 Aquastat (switch)
      c. Cooling Stage 1 Aquastat (switch)
      d. Cooling Stage 2 Aquastat (switch)
      e. ATWHP-1 tank probe (sensor)
      f. ATWHP-2 tank probe (sensor)
      g. ATWHP-3 tank probe (sensor)
   4. Each ATWHP (3 total) shall be provided with a 2-way motorized on/off valve, flow switch, tank probe temperature sensor, return water temperature sensor, and integral controller with capabilities as described in this Sequence of Operation.
   5. Each ATWHP (3 total) shall be provided with a Hand-Off-Auto (HOA) switch on the face of HCP-1.
      a. Each ATWHP (3 total) shall also be provided with a manual two-position selector switch for use with HOA switch hand-mode.
   6. The Hydronic Pumps (P-3 and P-4) shall each be provided with a VFD capable of the following:
      a. Receiving remote enable signal
      b. Duty/standby programming for two pumps
      c. Programming/operation in constant speed, constant pressure, or manufacturer's quadratic control curve programming.

B. Unit Staging
   1. ATWHP-1 shall be the stage 1 unit and ATWHP-2 shall be the stage 2 unit when timeclock located in HCP-1 is in time state #1.
   2. ATWHP-2 shall be the stage 1 unit and ATWHP-1 shall be the stage 2 unit when timeclock located in HCP-1 is in time state #2.
   3. ATWHP-3 shall be manual standby and enabled via hand switch on HCP-1.

C. Hydronic Pump Operation
   1. When any of the aquastats described in this Sequence of Operation are activated, an enable signal shall be sent to the pumps (P-3 and P-4) and the duty pump (P-3 or P-4) shall operate.
   2. The pumps shall be programmed for duty/standby rotation.
      a. P-3 and P-4 shall not operate simultaneously.
   3. The duty pump shall vary its speed as per the manufacturer's quadratic control curve programming to maintain relatively constant flow through each enabled unit (ATWHP-1, ATWHP-2, and/or ATWHP-3) as the units' motorized valves open/close.

D. Motorized Valves and Flow Switches
   1. The motorized valves shall be powered closed, normally open (spring open).
   2. The motorized valve for ATWHP-1 shall open upon the following conditions:
      a. Timeclock is in time state #1, OR;
      b. Timeclock is in time state # 2, AND;
         1) Cooling state 2 aquastat OR heating stage 2 aquastat is activated
      c. Loss of power to HCP-1
   3. The motorized valve for ATWHP-2 shall open upon the following conditions:
      a. Timeclock is in time state #2, OR;
      b. Timeclock is in time state # 1, AND;
         1) Cooling state 2 aquastat OR heating stage 2 aquastat is activated
      c. Loss of power to HCP-1
   4. The motorized valve for ATWHP-3 shall open upon the following conditions:
      a. The manual stanby hand switch on HCP-1 is toggled on, OR;
      b. Loss of power to HCP-1
   5. The enabled ATWHP unit(s) integral controller shall prevent the compressor(s) from operating until water flow is proven at the integral controller via the flow switch.

E. Cooling
   1. Upon a rise in the buffer tank (BT-1) temperature above 80°F (adj.) as measured by the cooling stage 1 aquastat, the stage 1 unit shall be enabled into cooling mode.
      a. The stage 1 unit shall operate in cooling mode until buffer tank cooling stage 1 aquastat temperature drops below 70°F (adj.), OR;
      b. The buffer tank temperature measured by the stage 1 unit's tank probe sensor drops below 69°F (adj.).

2. Upon a rise in the buffer tank (BT-1) temperature above 82°F (adj.) as measured by the cooling stage 2 aquastat, the stage 2 unit shall be enabled into cooling mode.
    a. The stage 2 unit shall operate in cooling mode until buffer tank cooling stage 2 aquastat temperature drops below 72°F (adj.), OR;
    b. The buffer tank temperature measured by the stage 2 unit's tank probe sensor drops below 69°F (adj.).
3. The manual standby unit (ATWHP-3) shall be enabled into cooling mode via the cooling stage 1 aquastat only when the manual hand switch on HCP-1 is toggled on. Upon being enabled, ATWHP-3 shall operate the same as the stage 1 unit as described above.

F. Heating
1. Upon a drop in the buffer tank (BT-1) temperature below 60°F (adj.) as measured by the heating stage 1 aquastat, the stage 1 unit shall be enabled into heating mode.
    a. The stage 1 unit shall operate in heating mode until buffer tank heating stage 1 aquastat temperature rises above 70°F (adj.), OR;
    b. The buffer tank temperature measured by the stage 1 unit's tank probe sensor rises above 71°F (adj.).
2. Upon a drop in the buffer tank (BT-1) temperature below 58°F (adj.) as measured by the heating stage 2 aquastat, the stage 2 unit shall be enabled into heating mode.
    a. The stage 2 unit shall operate in heating mode until buffer tank heating stage 2 aquastat temperature rises above 68°F (adj.), OR;
    b. The buffer tank temperature measured by the stage 2 unit's tank probe sensor rises above 71°F (adj.).
3. The manual standby unit (ATWHP-3) shall be enabled into heating mode via the heating stage 1 aquastat only when the manual hand switch on HCP-1 is toggled on. Upon being enabled, ATWHP-3 shall operate the same as the stage 1 unit as described above.

G. Hand-Mode Operation
1. When any of the ATWHP HOA switches are set to hand mode, the aquastat controls ability to enable that ATWHP shall be bypassed.
2. The ATWHP in hand mode shall still be prevented from operating until flow is proven at the integral controller via the flow switch.
3. Upon flow being proven, the unit shall operate based on its tank probe sensor. The tank probe sensor setpoints for cooling and heating are described above.
    a. The unit shall be enabled into cooling or heating mode based on the position of its manual two-position selector switch on the face of HCP-1.
4. (Note if the ATWHP's are turned to hand mode due to failure of the aquastat controls, the pump (P-3 OR P-4, not both) may need to be operated in hand as well.)

H. Unit Integral Stages
1. When operating in cooling or heating mode, the ATWHP integral controller shall compare the return water temperature as measured by that unit's return water

temperature sensor to the buffer tank (BT-1) temperature as measured by that unit's tank probe sensor to determine how many integral stages (number of compressors) should operate for that ATWHP.

2. There shall be a minimum runtime between stages as determined by the manufacturer to prevent compressor short cycling.

I. Safeties

1. The ATWHP integral controls shall include auto reset and manual reset high and low temperature limits. The high and low limit temperatures shall be determined by the manufacturer and factory set.
2. The ATWHP integral controls shall include high and low pressure safety switches. The pressure safety setpoints shall be determined by the manufacturer and factory set.

3.07 SEQUENCE OF OPERATION - WATER-TO-WATER HEAT PUMPS AND PUMPS

A. General:

1. This Sequence of Operation shall apply to the following equipment:
   a. WTWHP-1
   b. WTWHP-2
   c. Hydronic Pump - P-5
   d. Hydronic Pump - P-6
   e. Hydronic Pump - P-7
   f. Hydronic Pump - P-8
   g. Hydronic Pump - P-9
   h. Hydronic Pump - P-10
   i. Hydronic Pump - P-11
   j. Hydronic Pump - P-12
   k. Buffer Tank BT-2
2. The system shall be controlled by the Hydronic Control Panel (HCP-1). Refer to the HCP-1 Control Diagram.
3. Buffer Tank (BT-2) temperature shall be monitored by the following temperature sensors/switches:
   a. Heating Aquastat #1 (switch)
   b. Heating Aquastat #2 (switch)
   c. WTWHP-1 tank probe (sensor)
   d. WTWHP-2 tank probe (sensor)
4. Each WTWHP (2 total) shall be provided with two (2) flow switches, tank probe temperature sensor, and integral controller with capabilities as described in this Sequence of Operation.
5. Each WTWHP (2 total) shall be provided with a Hand-Off-Auto (HOA) switch on the face of HCP-1.
6. The Hydronic Pumps (P-5 thru P-12) shall each be provided with an integral speed controller capable of the following:
   a. Receiving remote enable signal
   b. Duty/standby programming for two pumps

c. Programming/operation in constant speed, constant pressure, or manufacturer's quadratic control curve programming.

7. The system shall be provided with two (2) outdoor air temperature switches.
   a. Outdoor Air Switch #1
   b. Outdoor Air Switch #2

B. Unit Rotation:
   1. WTWHP-1 shall be the duty unit when timeclock located in HCP-1 is in time state #1.
   2. WTWHP-2 shall be the duty unit when timeclock located in HCP-1 is in time state #2.

C. Hydronic Pump Operation:
   1. When either of the buffer tank (BT-2) aquastats is activated, the following pumps shall be enabled and shall operate:
      a. The source water pump associated with the duty WTWHP:
         1) P-5 if WTWHP-1 is duty, OR;
         2) P-6 if WTWHP-2 is duty.
      b. The heater-side pump associated with the duty WTWHP:
         1) P-7 if WTWHP-1 is duty, OR;
         2) P-8 if WTWHP-2 is duty.
   2. The system pump (P-9 or P-10) shall activate upon activation of any of the thermostats serving the unit heaters (UH-1 thru UH-3).
      a. The system pumps (P-9 and P-10) shall be programmed for duty/standby rotation and shall not operate simultaneously.
   3. The system pump (P-11 or P-12) shall activate upon activation of any of the thermostats serving the unit heaters (UH-4 thru UH-12).
      a. The system pumps (P-11 and P-12) shall be programmed for duty/standby rotation and shall not operate simultaneously.
   4. The pumps (P-5 thru P-12) shall be programmed for constant speed operation.

D. Flow Switches
   1. Upon being enabled into heating mode as described in this Sequence of Operation, the enabled WTWHP unit's integral controller shall prevent the compressor(s) from operating until water flow is proven in both water circuits via the flow switches.

E. Heating and Outdoor Air Reset
   1. When the outdoor air temperature is below 40°F (adj.) as measured by outdoor air switch #2 AND the buffer tank (BT-2) temperature drops below 137°F (adj.) as measured by heating aquastat #1, the duty WTWHP shall be enabled.
      a. The duty unit shall operate in heating mode until the buffer tank heating aquastat #1 temperature rises above 142°F (adj.), OR;
      b. The buffer tank temperature measured by the duty unit's tank probe sensor rises above 143°F (adj.).

2. When the outdoor air temperature is at or above 40°F (adj.) as measured by outdoor air switch #2 AND the buffer tank (BT-2) temperature drops below 129°F (adj.) as measured by heating aquastat #2, the duty WTWHP shall be enabled.
    a. The duty unit shall operate in heating mode until the buffer tank heating aquastat #2 temperature rises above 134°F (adj.), OR;
    b. The buffer tank temperature measured by the duty unit's tank probe sensor rises above 143°F (adj.).
3. When the outdoor air temperature rises above 55°F (adj.) as measured by outdoor air switch #1, heating aquastat #1 and heating aquastat #2 shall be disabled.

F. Hand-Mode Operation
1. When any of the WTWHP HOA switches are set to hand mode, the aquastat controls ability to enable that WTWHP shall be bypassed.
2. The WTWHP in hand mode shall still be prevented from operating until flow is proven at the integral controller via the flow switches.
3. Upon flow being proven, the unit shall operate based on its tank probe sensor. The tank probe sensor setpoint is described above.
4. (Note if the WTWHP's are turned to hand mode due to failure of the aquastat controls, the corresponding pumps (P-5 and P-7 for WTWHP-1, P-6 and P-8 for WTWHP-2) may need to be operated in hand as well.)

G. Safeties
1. The WTWHP integral controls shall include auto reset and manual reset high and low temperature limits. The high and low limit temperatures shall be determined by the manufacturer and factory set.
2. The WTWHP integral controls shall include high and low pressure safety switches. The pressure safety setpoints shall be determined by the manufacturer and factory set.

3.08 SEQUENCE OF OPERATION - HYDRONIC UNIT HEATERS

A. General:
1. This Sequence of Operation shall separately apply to the following units:
    a. UH-1
    b. UH-2
    c. UH-3
    d. UH-4
    e. UH-5
    f. UH-6
    g. UH-7
    h. UH-8
    i. UH-9
    j. UH-10
    k. UH-11
    l. UH-12

2. The unit heaters shall be controlled by the Hydronic Control Panel (HCP-1). Refer to the HCP-1 Control Diagram.
3. Each unit heater shall be provided with an aquastat and thermostat.

B. Heating Operation:
1. Thermostat setpoints shall be as follows:
   a. UH-1 = 55°F (adj.)
   b. UH-2 = 55°F (adj.)
   c. UH-3 = 55°F (adj.)
   d. UH-4 = 68°F (adj.)
   e. UH-5 = 68°F (adj.)
   f. UH-6 = 68°F (adj.)
   g. UH-7 = 60°F (adj.)
   h. UH-8 = 55°F (adj.)
   i. UH-9 = 58°F (adj.)
   j. UH-10 = 58°F (adj.)
   k. UH-11 = 58°F (adj.)
   l. UH-12 = 58°F (adj.)
2. The unit heater shall operate upon a drop in space temperature below the thermostat setpoint AND a rise in water temperature above the aquastat setpoint of 109°F (adj.).

3.09 SEQUENCE OF OPERATION - DOMESTIC HOT WATER HEAT PUMP AND PUMPS

A. General:
1. This Sequence of Operation shall apply to the following equipment:
   a. WTWHP-3
   b. Hydronic Pump - P-13
   c. Domestic Hot Water Pump - P-14
   d. Domestic Hot Water Storage Tank
2. The system shall be controlled by the Hydronic Control Panel (HCP-1). Refer to the HCP-1 Control Diagram.
3. The domestic hot water storage tank temperature shall be monitored by the following temperature sensors/switches:
   a. Aquastat (switch)
   b. WTWHP-3 tank probe (sensor)
4. WTWHP-3 shall be provided with two (2) flow switches, tank probe temperature sensor, and integral controller with capabilities as described in this Sequence of Operation.
5. WTWHP-3 shall be provided with a Hand-Off-Auto (HOA) switch on the face of HCP-1.
6. The Hydronic Pumps (P-13 and P-14) shall each be provided with a motor starter capable of the following:
   a. Receiving remote enable signal
   b. Hand-auto mode switch

B. Hydronic Pump Operation:
   1. When the domestic water tank aquastat is activated, the following pumps shall be enabled and shall operate:
      a. The source water pump P-13
      b. The domestic water circulator pump P-14

C. Flow Switches
   1. Upon being enabled into heating mode as described in this Sequence of Operation, the WTWHP unit's integral controller shall prevent the compressor(s) from operating until water flow is proven in both water circuits via the flow switches.

D. Domestic Water Heating:
   1. Upon a drop in the domestic water tank temperature below 140°F (adj.) as measured by the tank aquastat, the unit shall be enabled into heating mode.
      a. The unit shall operate in heating mode until domestic water tank aquastat temperature rises above 145°F (adj.), OR;
      b. The domestic water tank temperature measured by the unit's tank probe sensor rises above 146°F (adj.).

E. Hand-Mode Operation
   1. When the WTWHP HOA switch is set to hand mode, the aquastat controls ability to enable the WTWHP shall be bypassed.
   2. The WTWHP in hand mode shall still be prevented from operating until flow is proven at the integral controller via the flow switches.
   3. Upon flow being proven, the unit shall operate based on its tank probe sensor. The tank probe sensor setpoint is described above.
   4. (Note if the WTWHP is turned to hand mode due to failure of the aquastat controls, the corresponding pumps (P-13 and P-14) may need to be operated in hand as well.)

F. Safeties
   1. The WTWHP integral controls shall include auto reset and manual reset high and low temperature limits. The high and low limit temperatures shall be determined by the manufacturer and factory set.
   2. The WTWHP integral controls shall include high and low pressure safety switches. The pressure safety setpoints shall be determined by the manufacturer and factory set.

3.10 SEQUENCE OF OPERATION - ELECTRICAL ROOM AIR CONDITIONERS

A. General:
   1. This Sequence of Operation shall separately apply to the following systems:
      a. Indoor unit ERAC-1 and outdoor unit CU-1
      b. Indoor unit ERAC-2 and outdoor unit CU-2
   2. The unit shall be provided with an integral programmable controller, space thermostat, and outdoor air temperature sensor.

B. Cooling
   1. Occupied Mode
      a. Upon a rise in space temperature above 78°F (adj.), the system shall operate in cooling mode to maintain the setpoint temperature.
   2. Unoccupied Mode
      a. Upon a rise in space temperature above 80°F (adj.), the system shall operate in cooling mode to maintain the setpoint temperature.

C. Variable Speed Operation:
   1. The system fans and compressors shall vary speed in response to varying system load to best match load.

D. Economizer:
   1. Upon a drop in outdoor air temperature below the setpoint determined by the manufacturer, and there is a call for cooling, the compressors shall de-activate, and refrigerant shall be pumped via the economizer module.

3.11 SEQUENCE OF OPERATION - ENERGY RECOVERY VENTILATOR

A. General:
   1. This Sequence of Operation shall apply to the following equipment:
      a. ERV-1
   2. The unit shall be provided with a space occupancy sensor, timeclock,

B. The unit shall run if either of the following conditions is met:
   1. Space occupancy sensor is activated, OR;
   2. Timeclock is activated:
      a. Timeclock schedule shall be coordinated with the Owner for operation during occupied hours.

3.12 SEQUENCE OF OPERATION - EXHAUST FANS

A. General:
   1. This Sequence of Operation shall separately apply to the following equipment:
      a. EF-6
      b. EF-7

B. The exhaust fan shall run continuously.

C. Exhaust fan airflow shall be monitored with flow switches via the Airflow Monitoring Panel (AMP-1). Red LED lights and horn/strobe alarms shall activate upon loss of detection of airflow. Refer to the AMP-1 Control Diagram.

3.13 SEQUENCE OF OPERATION - EXHAUST FAN

A. General:
   1. This Sequence of Operation shall apply to the following equipment:
      a. EF-8

2. The exhaust fan shall be provided with a timeclock and a wall mounted spring timer dial/knob.

B. The exhaust fan shall operate for approximately 20 minutes (adj.) two (2) times per day, or as otherwise scheduled by the Owner via the timeclock; OR when the wall mounted spring timer dial/knob is manually activated.

3.14 SEQUENCE OF OPERATION - VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

A. General:
   1. This Sequence of Operation shall separately apply to the following systems:
      a. VRF-1
         1) AC-1A
         2) AC-1B
      b. VRF-2
         1) AC-2A
         2) AC-2B
      c. VRF-3
         1) AC-3
   2. Each indoor AC unit shall be provided with a programmable wall mounted thermostat.

B. Heating
   1. Occupied Mode
      a. Upon a drop in space temperature below 68°F (adj.), the AC unit shall operate in the heating mode to maintain the setpoint temperature.
   2. Unoccupied Mode
      a. Upon a drop in space temperature below 64°F (adj.), the AC unit shall operate in the heating mode to maintain the setpoint temperature.

C. Cooling
   1. Occupied Mode
      a. Upon a rise in space temperature above 76°F (adj.), the AC unit shall operate in cooling mode to maintain the setpoint temperature.
   2. Unoccupied Mode
      a. Upon a rise in space temperature above 80°F (adj.), the AC unit shall operate in cooling mode to maintain the setpoint temperature.

3.15 SEQUENCE OF OPERATION - ELECTRIC UNIT HEATERS

A. General:
   1. This Sequence of Operation shall apply to the following unit:
      a. EUH-1
   2. Electric unit heater shall be provided with a wall mounted thermostat.

B. Heating

1. Upon a drop in space temperature below 53°F (adj.), the heater shall operate.

+ + END OF SECTION + +

SECTION 15990

TESTING, ADJUSTING, AND BALANCING OF AIR AND HYDRONIC HVAC SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified, and required to perform the testing, adjusting, and balancing for all HVAC systems.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the testing, adjusting, and balancing Work.

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. AABC National Standards for Total System Balance.
   2. ASHRAE Handbook – Fundamentals.
   3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
   4. SMACNA HVAC Systems – Testing, Adjusting & Balancing Handbook.

1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Balancer:
      a. Engage an experienced balancer to perform the Work of this Section who has specialized in testing, adjusting, and balancing HVAC systems similar to that required for this Project.
      b. Minimum of five years of experience in testing, adjusting, and balancing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years in the continental United States.
      c. Submit name and qualifications to Engineer along with the following information on a minimum of five successful projects:
         1) Names and telephone numbers of owners, architects or engineers responsible for projects.
         2) Approximate contract cost of the testing, adjusting, and balancing Work.
         3) Amount of area tested, adjusted, and balanced.

4) Biographical information on employee proposed to directly supervise the testing, adjusting, and balancing Work.

B. Regulatory Requirements:
1. Associated Air Balance Council (AABC).
2. National Electrical Code (NEC).
3. National Environmental Balancing Bureau (NEBB).
4. National Fire Protection Association (NFPA).
5. Underwriters Laboratories Inc. (UL).
6. Local and State Building Codes and Ordinances.
7. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:
1. Product Data:
a. Data sheets with name of devices, manufacturer's name, model number, latest date of calibration, and correction factors for each testing, adjusting, and balancing instruments.
b. Other technical data related to specified material and equipment as requested by Engineer.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Certification by National Environmental Balancing Bureau (NEBB), Association Air Balance Council (AABC), or equal.
2. Source Quality Control Submittals:
a. Specimen copies of report forms for Engineer's review and approval.
1) Forms shall be 8-1/2 by 11-inch paper for loose-leaf binding, with blanks for certification of report and listing all required testing, adjusting, and balancing requirements and ratings.
3. Field Quality Control Submittals:
a. Written startup and field test reports presenting results of required field testing, adjusting, and balancing.
1) Certified reports shall be in typed format on approved forms imprinted with the company's name.
2) Reports shall include procedure outline used to test, adjust, and balance the systems and the types of instruments used.
3) Minimum three certified copies of testing, adjusting, and balancing reports to the Engineer for review.
4) Reports must be submitted to Engineer and Owner for approval prior to Owner's acceptance for responsibility.
4. Qualifications Statements:
a. Balancer, when requested by Engineer.

C. Closeout Submittals: Submit the following:

1. Maintenance Contracts:
    a. Maintenance and Repair:
        1) Provide all labor, tools, and equipment to provide a Preventive Maintenance Program and make repairs for all equipment and controls during the One Year Correction Period after the Final Acceptance by Owner. Contractor shall provide the following services for the same period of one year:
            (a) Receive calls for all problems and take steps to immediately correct deficiencies, which may exist.
            (b) Provide a monthly inspection of all equipment, and record the findings on a checklist hereinafter specified.
            (c) Provide a Preventive Maintenance Schedule for the principle items of equipment.
            (d) Respond to Owner and make repairs for all equipment and controls within 24-hours of notification by Owner.
    b. Check List:
        1) Provide a checklist and post a copy of it, where directed by the Owner.
        2) Include each piece of equipment specified or shown.
        3) Provide four columns for required quarterly inspections.
        4) Provide columns for the following:
            (a) Equipment condition.
            (b) Equipment operation.
            (c) Equipment lubrication.
            (d) Preventive maintenance.
        5) Preventive maintenance shall be performed in accordance with the manufacturer's recommendations and accepted practice.

1.05 SITE CONDITIONS

A. HVAC Environmental Requirements:
    1. Testing, adjusting, and balancing shall be performed when outside ambient conditions are approximate to the local ASHRAE Handbook – Fundamentals design conditions (14 degrees F for heating and 92 degrees F for cooling) for all heating and cooling functions.

PART 2 PRODUCTS

2.01 EQUIPMENT PERFORMANCE

A. Equipment Description:
    1. Air Balance Instruments:
        a. Provide all velometers, anemometers, pitot tubes, differential air pressure gages, manometers, hook gages, static pressure probe units, and all other instruments and accessories as required to perform all air balance tests of equipment, ducts, registers, grilles, etc.
        b. Flow-measuring hoods (manufactured, not fabricated) shall be acceptable for measurement of ceiling diffuser performance only.

2. System Performance Measuring Instruments:
    a. Provide insertion thermometers, sling psychrometers, tachometers, revolution counters, clamp-on volt-ammeter recorders, and other instruments as required to measure all facets of the complete systems performance.

B. Performance Criteria:
    1. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards demanded by these organizations.

2.02 ACCESSORIES

A. Balancing Sheaves and Belts:
    1. Balancing sheaves and belts shall be provided for all belt driven equipment.
    2. Sheaves and belts shall be provided to match construction and duty provided by the equipment manufacturer.
    3. Equipment sheaves and belts replaced or not required to achieve balancing shall be submitted to the Owner as spare parts.

2.03 IDENTIFICATION

A. All equipment and component identification, including valve tags, shall be provided in accordance with Section 15075 - Mechanical System Identification for HVAC Systems.

PART 3 EXECUTION

3.01 INSPECTION

A. Equipment and components shall be completely installed and in continuous operation, as required, to accomplish the testing, adjusting and balancing Work specified.

B. Inspect all equipment and components for proper operation prior to testing, adjusting and balancing.
    1. Fan Belt Deflection: Not less than 1/4-inch or more than 1/2-inch.
    2. Finned Coils: Plate type fins shall be combed out with a fin comb for the appropriate fin spacing. Helical fins shall be straightened with blunt bladed instrument.

C. Pre-Startup Inspection:
    1. Verify proper equipment mounting and setting.
    2. Verify that control, interlock and power wiring is complete.
    3. Verify alignment of motors and drives.
    4. Verify proper piping connections and accessories.
    5. Verify that lubrication is completed.

D. First Run Observations:
    1. Verify direction of rotation.
    2. Verify setting of safety controls.

3. Monitor heat build-up in bearings.
4. Check motor loads against nameplate data.

E. Equipment Check:
1. Verify proper overload heater sizes.
2. Verify function of safety and operating controls.
3. Verify proper operation of equipment.
4. Report on inspection, observation and checking procedures.

F. Promptly report defects which may affect the Work to Engineer.

G. Should corrective measures caused by faulty installation require re-testing, adjusting and balancing, such Work shall be at no additional cost to the Owner.

3.02 APPLICATION

A. General:
1. Test, adjust, and balance all systems, ductwork, piping, etc. and their control systems in accordance with the AABC National Standards for Total System Balance, NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems, SMACNA HVAC Systems – Testing, Adjusting & Balancing Handbook, or in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with Contractor. Contractor shall submit one copy of the standard procedure manual to the Engineer for their records.
2. Contractor shall provide all necessary instruments, tools, ladders, etc. to complete all testing, adjusting, and balancing Work.
3. Contractor shall assume full responsibility for safe keeping of all instruments, tools, ladders, etc. during the course of the Work.
4. Contractor shall be solely responsible for the protection and safeguarding of the Work and shall provide every protection against accidents, injury, and damage to persons and property.
5. Contractor shall keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day's Work.
6. Contractor shall be fully responsible for removal and reinstallation of ceiling system and replacement of any component damaged.
7. Contractor shall install additional access panels at no extra cost to the Owner, as is required to gain access to equipment concealed above ceilings, behind walls, or any other concealed space.
8. Systems shall be tested, adjusted, and balanced with clean filters and strainers.
9. Where equipment is provided with a variable speed controller (VSC) or variable frequency drive (VFD), balance the equipment first with the VSC or VFD and then with balancing dampers (air systems). All systems shall be optimized through the VSC or VFD by balancing with the minimum static pressure needed to meet design flow conditions.

B. Air Systems:
   1. Preliminary:
      a. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals.
   2. Central Systems:
      a. Test rpm for all equipment, including adjusting of each fan, air handling unit, and air conditioning unit to design requirements within the limits of mechanical equipment provided.
      b. Test and record motor voltages and running amperes including motor nameplate data, and starter heater ratings for each unit as listed above.
      c. Make pitot tube traverse of main supply, exhaust and return ducts, determine airflow at all fans and units and adjust fans and units to within five percent of design requirements.
      d. Test and record system static pressure, suction and discharge.
      e. Test and adjust system for design outside air, (cfm).
      f. Test and adjust system for design recirculated air, (cfm).
      g. Test and record heating apparatus entering air temperatures, (dry bulb).
      h. Test and record cooling apparatus entering air temperatures, (dry bulb and wet bulb).
      i. Test and record heating apparatus leaving air temperatures, (dry bulb).
      j. Test and record cooling apparatus leaving air temperatures, (dry bulb and wet bulb).
      k. Record all fan and air handling unit speeds.
      l. Record air quantity delivered by each fan and air-handling unit.
   3. Distribution:
      a. Adjust volume dampers, control dampers, splitter dampers, etc., to proper design airflow in main ducts, branch ducts, and zones.
   4. Air Terminals:
      a. Identify each air terminal as to location and determine required flow reading.
      b. Test and adjust each air terminal to within tolerance of design requirements as listed below.
         1) Positive Zones:
            (a) Diffusers and Supply Air Terminals: 0 percent to +10 percent.
            (b) Exhaust and Return Air Terminals: 0 percent to -10 percent.
         2) Negative Zones:
            (a) Diffusers and Supply Air Terminals: 0 percent to -10 percent.
            (b) Exhaust and Return Air Terminals: 0 percent to +10 percent.
         3) Neutral Zones:
            (a) All Air Terminals: -10 percent to +10 percent.
      c. Test procedure on air terminals shall include recording comparison of required airflow and observed airflow, adjustment of terminal, and recording of final airflow.
      d. Adjust flow patterns from air terminal units to minimize drafts to the extent that the design and equipment permits.
   5. Verification:

a. Prepare summation of readings of observed airflow for each system, compare with required airflow, and verify that duct losses are within specified allowable range.
b. Verify design airflow at fans as described above.
c. If determined that the air system has not been properly balanced, Contractor shall rebalance and recheck all equipment and components in the presence of the Engineer and as accepted by the Engineer.

C. Water Systems:
1. Preliminary:
a. List all mechanical specifications of tested equipment and verify against the Contract Documents.
b. Open all valves in all lines to full open position.
c. For each pump, verify rotation.
d. Verify proper water level in the system.
2. Central Equipment:
a. Set pumps to provide proper flow quantity.
3. Distribution:
a. Adjust balance valves, control valves, etc., to proper design flow rates (gpm).
4. Flow Balancing Devices:
a. Upon completion of adjustments mark all settings and record data:
5. If determined that the water system has not been properly balanced, Contractor shall rebalance and recheck all equipment and components in the presence of the Engineer and as accepted by the Engineer.

3.03 FIELD QUALITY CONTROL

A. Balancer's Services:
1. Provide a qualified, factory-trained service person to perform the following:
a. After equipment installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
2. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.04 SCHEDULES

A. Test, adjust, and balance all HVAC equipment and associated systems in all operating modes and under both heating and cooling design conditions where applicable.

+ + END OF SECTION + +

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SECTION 16010

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General electrical requirements shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The Contractor shall provide all labor, materials and equipment required to perform the work as specified in the Specifications and as shown on the Contract Drawings. The work shall also include the following:

1. Inserts and other electrical items which shall be installed embedded in concrete, or built into walls, partitions, ceilings or panels.

2. Installation procedures and schedules under other contracts shall be reviewed and coordinated with other Subcontractors regarding the installation of electrical items that must be installed.

3. Keep informed of the construction so the electrical work shall be installed within such time periods as will not delay the work of the other Subcontractors.

4. Notify other Subcontractors in advance of the installation of the work included, so they shall have sufficient time for coordination and installation of interrelated items that are included in their contracts and that must be installed in conjunction with the work included under this Contract.

C. The existing plant will be maintained in continuous operation during the entire construction period of all contracts. Work under each contract shall be so scheduled and conducted by each Contractor that such work will not impede any treatment process, reduce the quality of the plant effluent or cause odor or other nuisance. In performing the work shown and specified, the Contractor shall plan and schedule his work to meet the plant and collection system operating requirements.

D. The Contractor has the option of providing additional temporary facilities that can eliminate a constraint, provided it is done at no additional cost and provided that all requirements of these specifications are fulfilled. No plant personnel will be available to supervise, operate or maintain any temporary facilities. Work not

specifically covered in the following paragraphs may, in general, be done at any time during the contract period, subject to the operating requirements outlined hereinafter. All references to days in this section are to consecutive calendar days, except where noted. All references to schedule completion dates shall mean the date noted in the latest revision of the CPM schedule.

E. It shall be the responsibility of the Contractor to move all equipment, desks, stored materials, etc. from one building to another. All moves shall be scheduled and coordinated with the Engineer.

1.2 RELATED SPECIFICATIONS

A. Specification 01700 – Maintenance of Plant Operations

B. Specification 09900 – Painting.

C. Specification 16292 – Power Distribution System Coordination

D. Specification 16036 – Testing

1.3 PAYMENT

A. Payment for general electrical requirements shall be made as provided for in the Specifications.

1.4 REFERENCES

A. General electrical requirements shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. NEMA, National Electrical Manufacturers Association.
   3. UL, Underwriters Laboratories Incorporated.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Point-to-point field wiring diagrams.
   2. Qualifications of proposed wiring coordinator who shall prepare the point-to-point field wiring diagrams.

C. Reports: Demonstration of equipment report shall be submitted.

1.6 QUALITY ASSURANCE

A. General:
   1. All equipment and devices, provided under each Contract, shall be properly connected and interconnected with other equipment and devices so as to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Contract Drawings.
   2. Similar products shall be by the same manufacturer for uniformity on the Contract.
   3. Electrical material and equipment shall be new and shall bear the label of UL, or other nationally recognized, independent testing laboratory, wherever standards have been established and label service regularly applies.
   4. Where execution of the work under this Contract requires certain systems and equipment to be modified, the Contractor shall perform the work with due regard to maintenance of operations and construction staging in accordance with the Specifications.
   5. The modification work shall be coordinated in advance with the plant superintendent and existing conditions. Contractor shall field determine and make such investigations as required to determine the functionality of each circuit and identify circuit terminations as required for the modifications intended to ensure the proper interface of all components for a complete functional system.
   6. The Contractor shall retain the services of a wiring coordinator, to prepare the point-to-point field wiring diagrams. The wiring coordinator shall have experience in the development of the diagrams of the type specified and shall have served in a similar role on a project of similar size and complexity.

B. Area Classifications:
   1. Materials and equipment for all indoor areas shall conform to the area classifications shown on the Contract Drawings or stated in the Specifications.
   2. Materials and equipment for all outdoor areas shall conform to corrosive requirements, unless shown otherwise on the Contract Drawings or stated in the Specifications.
   3. The locations and requirements shall be in accordance with the following:
      a. Materials, equipment and incidentals installed in corrosive areas shall meet NEC and NEMA requirements for corrosive locations. Enclosures installed in corrosive locations shall meet NEMA 4X requirements. All exterior areas for this Contract are noted as NEMA 4X.

b. Materials, equipment and incidentals installed in hazardous locations shall meet NEC requirements for the Class and Division designated. Enclosures installed in hazardous locations shall be provided with stainless steel hardware and watertight gasketing.
c. Materials, equipment and incidentals installed in dusty locations shall meet NEC and NEMA 12 requirements. The interiors of all unit substation buildings are noted as NEMA 12.

1.7 GENERAL CONSTRAINTS

A. General: Under Paragraph 1.09, Sequence of Construction and Operation, herein, the sequence for units which are to be taken out of service for renovation and remedial work is outlined for each area. The operational status of completed or existing units other than the designated units shall not be interrupted by the Contractor. New units may only be used after the specified testing and acceptance of the units.

B. Accidental Shutdown: In the event of accidental shutdown of plant equipment the Contractor shall notify plant personnel immediately to allow for an orderly restart of affected equipment.

C. Access to Plant Site: An unobstructed traffic route through the plant must be maintained at all times for the plant equipment and personnel.

D. Access on Internal Roads: Vehicular access to the treatment units and buildings must be maintained at all times.

E. Personnel Access: Treatment plant personnel must have access to all areas which remain in operation throughout the construction period. The construction work must be phased, and access for plant workers must be maintained during construction.

F. Power, Light and Communication Systems: Electric power, lighting service and communications systems shall be maintained in uninterrupted operation in all areas which remain in operation. Individual units may be disconnected as required for replacement.

G. Sump Pumps and Sumps: All existing pumps shall be maintained in an operable condition with either existing pumps or temporary pumps. Interim piping, power and controls shall be provided as required by the staged construction sequence.

H. Service Interruptions:
1. When a construction task requires a suspension of normal operations of a plant utility system for a period of less than twenty-four (24) continuous hours, the suspension shall be considered a service interruption.

2. The contractor shall compile an inventory of the labor and materials required to perform the tasks, an estimate of the time required and a written description of the steps required to complete the task resulting in a service interruption. The inventory, time estimate and written procedure shall be submitted to the Engineer for review sixty (60) days prior to the start date of the task as defined in the CPM schedule. If the proposed procedure submitted by the Contractor is acceptable, the Engineer shall authorize in writing, the service interruption pending the verification of materials and labor and the final notification specified therein.
3. No service interruption shall be initiated until the list of materials and labor is verified by the Engineer as on site at least one week prior to the proposed start date. After verification of the list of materials and labor, the Contractor shall notify the Engineer of the exact date that he wishes to perform the work in writing two (2) normal working days, excluding Saturdays, Sundays and holidays, prior to the proposed date.
4. When the normal operations of a plant utility system unit are suspended longer than twenty-four (24) hours, then the procedures for a shutdown, specified hereinafter, shall be enforced.

1.8 PRIOR, CURRENT AND FUTURE CONSTRUCTION CONTRACTS

A. Refer to Specification 01120- Contract Summary

1.9 SEQUENCE OF CONSTRUCTION AND OPERATION

A. In order to maintain continuous plant operation during construction, a phased removal, construction and operational sequence will be required as described herein. The order in which the principal structures or work areas are presented herein is for convenience of presentation and is not intended as a sequence of work or a listing of priorities. The Contractor is advised that work in multiple areas of the plant must be performed simultaneously in order to complete the entire scope of the contract within the allotted time. The Contractor is advised that the presentation is not organized in accordance with specific trades. The work sequence described herein as being required to complete a building, an area or a process shall be considered all-encompassing for all trades.

B. Refer to Specification 01310 – Maintenance of Plant Operations for Electrical work phasing and sequencing requirements.

1.10 TEMPORARY FACILITIES

A. Temporary facilities shall be provided in accordance with the requirements of Division 1, Maintenance of Plant Operations.

B. Temporary facilities shall be any equipment, materials, controls, services and accessories temporarily needed for access to and for protection of all existing structures and equipment, and to maintain an operating system, all in accordance with the provisions of these Specifications.

C. The size or capacity of the temporary facility shall generally be equal to the size or capacity of the facility replaced, unless otherwise directed by the Engineer.

1.11 INTERIM AND TEMPORARY MATERIAL AND EQUIPMENT

A. The Contractor shall furnish, install and remove the interim material and equipment in accordance with the Contract Documents.

B. The Contractor is responsible for the removal from the site of all interim material and equipment and disposal thereof in accordance with the Specifications.

C. Temporary material and equipment is material and equipment which must be furnished by the Contractor based on his method of construction for maintaining a treatment process for a specific period, or the utility or service systems during the installation or connection of new equipment or material. For specific cases, the location and general routing of temporary equipment and material has been shown for the convenience of the Contractor and to ensure minimal disruption of plant operations during the equipment installation. The Contractor is advised that temporary connection between the existing and new service shall be necessary to comply with the General Constraints specified herein.

1.12 ADDITIONAL PROVISIONS

A. Shutdowns:
   1. Before commencing work on any of the existing equipment which requires a shutdown or suspension of normal operations, the Contractor shall request permission from the Engineer, in writing, at least sixty (60) days in advance of the date he proposes to commence such work. A date in a CPM schedule shall not constitute proper notification. In the request, the Contractor shall explain what construction procedures shall be used during the shutdown.
   2. The Contractor is prohibited from shutting down any treatment units or equipment before obtaining written authorization from the Engineer to proceed with such operations; such authorization shall, however, not be construed as a waiver of the requirements for the uninterrupted operation

of the plant. A final notification in writing shall be submitted by the Contractor two (2) normal working days excluding Saturdays, Sundays and holidays, in advance of the actual shutdown.

B. Protection of Underground and Covered Facilities: The location and extent of these facilities are not guaranteed, and the Contractor is cautioned to proceed with care, in the construction of new work in order to prevent damage to any existing structures, piping, or facilities. Protection and support for all underground facilities shall be provided to insure that the service provided for all existing facilities will not be interrupted. Any rerouting of the existing facilities to facilitate construction operation shall be only with written permission of the Engineer and then in the manner and at the time approved by the Engineer. The rerouting shall be made at no additional cost. Contractor shall pay for all damage to existing underground facilities that he causes and compensate the County for any service interruption caused by such damages.

C. Special Protection of Machinery and Equipment:
1. The Contractor shall take all protective measures to the satisfaction of the Engineer necessary to insure that inclement weather or dust and debris from demolition does not enter any of the mechanical or electrical equipment enclosures. Enclosures shall be provided where necessary to prevent contamination of the air. All protective measures shall be furnished, installed, lighted, ventilated, maintained and removed at the Contractor's own cost. The Contractor shall pay for all damage to machinery and equipment caused by his failure to adequately protect it.
2. Interior dustproof covers shall be a heavy reinforced polyethylene film curtain, minimum thickness 6 mils, supported by wood framing. All seams and penetrations shall be sealed with duct tape on two sides. Junctions with existing walls, floors and ceilings shall be made with a double fold secured with a backing strip anchored to the existing wall, floor and ceiling.
3. Exterior weather tight enclosures shall be provided whenever a section of a roof or exterior wall on an existing building is removed or equipment is installed in a new building.

D. Site Visit: The Contractor, before submitting his proposal, shall visit the site and shall be responsible for having ascertained local conditions, such as location, accessibility and general character of the site, the character and extent of any existing work within or adjacent to the site, and any other work being performed on the site at the time of submitting his proposal. The Contractor shall fully examine all the drawings relating to the work and shall become completely informed as to the extent and character of the work required and prevailing existing condition. No allowances will be made for the Contractor's failure to avail himself of such information.

E. Existing Cables and Conduits

1. It is anticipated that several branch circuit conduits and/or lights may have to be routed, extended, relocated or temporarily removed and replaced, to permit the installation or removal of equipment by other trades under this Scope of Work. Review all drawings and allow for the rerouting or relocation of wiring systems and devices to remain which must be relocated or rerouted. This Contractor shall include these costs in his bid price, and accomplish these rework items to suit field requirements and conditions.
2. When working with existing equipment or wiring systems, care shall be taken to avoid damage, and shutdown of process equipment. Prior to working in an area, Contractor shall examine existing conditions and file an inspection report with the Engineer. Any additional defects which result from the Contractor's work, will result in the Contractor being held liable for damage to existing equipment.
3. Where new construction involves connecting to or using existing equipment, the Contractor shall include in his bid price, all cost, work and materials required to adapt, extend or rework the prevailing existing "As Is" condition, to the new work. Should an existing condition prove to be grossly deteriorated or inadequate for modification, such condition shall be reported to the Engineer for a remedy.
4. Where existing empty conduits are to be used for new wiring systems, they shall be assumed to be in poor condition requiring prior "make ready" work before using. A wire brush reamer shall be pulled through prior to wiring and, if necessary, water accumulations shall be pumped or blown out.
5. Contractor shall trace and tag all wires before these are relocated and reconnected from the equipment. Contractor shall coordinate removal of wires with the Field Engineer.
6. The Contractor's attention is directed to the requirement that he shall work on an existing Sewage Treatment Plant which shall remain in operation.
7. As indicated on the plans, certain equipment and/or wiring systems are being taken out of active service permanently and the Contractor shall perform all work required to remove or safely abandon existing systems.
8. The following describes the intended work scope for removals:
    a. The Contractor shall arrange for the safe de-energization of all electrical equipment.
    b. Feeder and branch wiring, conduits and boxes routed exposed shall be removed in their entirety by the Contractor.
    c. Feeder and branch wiring and conduits in earth, concrete slabs or masonry shall be abandoned in place, except that wiring ends shall be cut off (or removed) at the conduit mouth by the Contractor. When feeder and branch wiring and conduits interfere with the installation of any new project work they shall be removed in their entirety by the Contractor. Conduits which exit floor slabs, and walls, shall be cut or

hammered down, flush with floor level or wall and filled with epoxy concrete by the Contractor.

9. Generally all equipment, boxes, fixtures, etc. shall be removed from the site and disposed of at Contractor's expense, or delivered to an on-site storage area when the Engineer directs.
10. The Contractor shall be responsible for all damage to existing structures, equipment, and facilities caused by his construction operations and must repair all such damage when and as ordered at no additional cost.

F. Emergency Repair Crews: In case the Contractor's operations disrupt the treatment process or the minimum operating facilities herein before described, at any time, he shall at his own cost immediately make all repairs or replacements and do all work necessary to restore the plant to operation to the satisfaction of the Engineer. Such work shall progress continuously to completion on a 24-hour day, seven work-day week basis. The Contractor shall provide the services of emergency repair crews, available on call 24 hours per day.

PART 2 - PRODUCTS

2.1 POINT-TO-POINT FIELD WIRING DIAGRAMS

A. The Contractor shall provide point-to-point field wiring diagrams for all equipment, including equipment provided by other Contractors.

B. The diagrams shall be developed for performance of the work and to document terminations. The diagrams shall be prepared based upon approved shop drawings of related Contracts, working drawings and inspections as necessary to complete the diagrams. The diagrams shall include:

1. External wiring for each piece of equipment, panel, instrument and other devices to control stations, lighting panels and motor controllers. The diagrams shall include control, status, signal and power wiring. Power diagrams shall include connections to switchgear, motor control centers, panelboards, panels and field devices.
2. Numbered terminal block identification for each wire termination.
3. Identification of the assigned wire numbers and color coding for all interconnections.
4. Identification of all wiring by the conduit tag in which the wire is installed.
5. Terminal, junction, and pull boxes through which wiring is routed.
6. Identification of equipment with functional name and number to which wiring is to be connected.

2.2 SHOP FINISHES

A. Electrical equipment shall be shop painted in accordance with the requirements of Specification 09900.

B. Exposed ferrous metal surfaces except aluminum, bronze, brass and stainless steel components shall be cleaned with a commercial blast and primed with one coat of rust inhibitive primer.

C. Manufactured assemblies such as switchgear, substations, motor control centers, panelboards and motor controllers shall be shop painted in accordance with the requirements of Specification 09900.

D. Other equipment shall be painted with the manufacturer's best grade finish paint system compatible with the finish coatings specified in Specification 09900.

PART 3 - EXECUTION

3.1 MAINTENANCE OF OPERATIONS

A. Where execution of the work under this Contract requires certain equipment to be taken out of service, the Contractor shall perform the work with due regard to maintenance of operations and construction staging in accordance with the Specification Section 01310 Maintenance of Plant Operations.

B. The Contractor shall schedule the work in advance with the Engineer so as not to affect proper plant operations. When the work is scheduled, the Engineer shall be notified 48 hours prior to proceeding with the work to allow time for the plant superintendent to perform load switching and alternation of equipment.

C. To the maximum extent possible at the end of the workday, all equipment shall be back in place and ready for its normal service use should a plant emergency arise. In addition, should an emergency condition occur during execution of the work, at the request of the plant engineer, the equipment shall be placed back in service immediately and turned over to plant personnel.

D. In the event of accidental shutdown of plant equipment the Contractor shall notify plant personnel immediately to allow for an orderly restart of affected equipment.

3.2 DEMONSTRATION OF EQUIPMENT

A. The Contractor shall demonstrate, in the presence of the Engineer that all electrical systems and electrically operated equipment operates as specified, designed and as required.

B. The Contractor shall coordinate the demonstration of the electrical systems which are part of other Contracts with the other Subcontractors.

C. The demonstration of equipment shall include the following:

1. All power circuits shall be operated to verify proper connection to equipment. Mechanical key-interlocks for circuit breakers shall be operated to verify their proper operation. Power shall be removed and reapplied to automatic transfer switches to verify their operation.
2. Emergency power systems shall be activated to verify their automatic start-up, proper operation while running and proper deenergization and cool down upon availability of normal power.
3. All pushbuttons, indicating lights and similar devices shall be operated to verify proper connection and function. All devices, such as pressure and flow switches and similar devices shall be operated to verify that shut-downs and control sequences operate as required.
4. The Contractor, with coordination of the other Subcontractors, shall operate the systems to verify wiring and adjust the controls, as required, to achieve proper operation. This shall include wiring, timing and switching functions.
5. Lighting and Receptacle Systems
    a. All lighting systems shall be operated to verify proper switching and proper circuit wiring. Emergency lighting systems shall be operated to verify proper switching, circuit wiring and response to loss of primary power.
    b. Receptacle circuit wiring shall be verified to agree with panelboard schedules.
6. Protective relaying and breaker protection systems/settings shall be set and operated and detailed in Specification 16292 - Power Distribution System Coordination.
7. All instrumentation systems shall be operated to verify that wiring and data transmission is correct.
8. The Contractor shall coordinate the demonstration of the electrical systems which are part of other systems (HVAC, plumbing, mechanical, instrumentation) with the other Subcontractors. The Contractor shall operate the systems to verify that the wiring is correct and that all controls operate as required.

3.03 RESTORATION

A. The Contractor shall field paint after installation marred or scratched surfaces. All scratches, abrasions and other damage to equipment shall be touch-up painted in accordance with the requirements of Specification 09900.

+ + END OF SECTION + +

NO TEXT ON THIS PAGE

SECTION 16020

TEMPORARY ELECTRICAL WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown specified and required to furnish and install interim electrical work in accordance with the requirements of Specification 16020 - Temporary Electrical System. The temporary electrical system shall be furnished and installed in accordance with the requirements specified under this Section, the Specifications and the Contract Drawings.

B. The temporary electrical system shall supply power and light as required for the construction related activities. The temporary electrical system shall be complete and shall include all auxiliary equipment necessary to support the construction.

1.2 RELATED SPECIFICATIONS

A. Specification 16061 - Grounding.

1.3 PAYMENT

A. Payment for the temporary electrical system shall be made as provided for in the Specifications. Payment for furnishing, installing, energizing, maintaining and removing the temporary electrical system and for electrical energy consumed thereby shall be made as stated in the Specifications.

1.4 REFERENCES

A. Temporary electrical system shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. National Electrical Safety Code.
   3. Local Codes
   4. Local Utility Requirements
   5. OSHA Regulations

1.5 SYSTEM DESCRIPTION

A. The Contractor shall make all necessary arrangements with the Plant and shall provide a temporary electrical service point connection. Connecting lines and service supply shall be of sufficient capacity to supply all temporary light and power required on the site.

B. Arrangements shall be made with the Plant immediately after notice to commence work in accordance with the Specifications.

C. The service shall have provisions for meter connections for each Contractor on the work site and the Resident Engineer. The service shall be branched and metered using circuit breakers or fused switches and meters.
   1. The distribution from each meter to the Contractor's field office and shops at the site shall be the responsibility of each Contractor.
   2. The distribution from one (1) meter to Resident Engineer's field office shall be the responsibility of the Contractor.
   3. The distribution from one (1) meter to the construction temporary light, power, and security system shall be the responsibility of the Contractor.

D. Each Contractor shall be responsible for making arrangements with the Utility to have a sealed meter installed and for payment of same.

E. The energy charges for each Contractor's field office and shop usage shall be the responsibility of the Contractor.
   1. Energy charges associated with the Resident Engineer's field office shall be the responsibility of the Contractor. The energy charges for each Subcontractor's usage shall be the responsibility of the Contractor. Energy charges associated with the work areas general power and lighting and the security site lighting shall be responsibility of the Contractor.

F. Each Contractor requiring additional temporary power and light, beyond that provided under by the Contractor as specified herein, shall arrange with the utility for such additional temporary power and light and shall bear the costs of all material and ancillary equipment necessary.

G. When specifically stated in the Specifications, the service supply can be obtained from the plant permanent facilities and the cost of the energy will be borne by the

County.

1.6 DESIGN REQUIREMENTS

A. The Contractor shall provide all systems and circuits in accordance with NFPA 70, the National Electrical Safety Code, local codes, Utility codes, and OSHA requirements.

B. The temporary electrical system shall be provided in accordance with the following design requirements:

1. Each Contractor and the Resident Engineer trailer complex shall have a separate branch.
2. A separate branch shall supply the work area general lighting, power, and security. Receptacles (GFI type) shall be located throughout the work area. Receptacle connected equipment shall be suitable for 120 volt operation. Operating input shall not exceed 1500 volt-amperes. Illumination levels shall be as required by OSHA.
3. Security site lighting circuits shall supply a system of security lighting for the work area, field office complex(s), Contractors' staging areas, and all parking areas. Unless specifically shown otherwise on the Contract Drawings or stated in the Specifications, the system shall be arranged to provide a minimum lighting intensity of 5 foot candles in these areas.
4. A total of three (3) 200 amperes and three (3) 100 ampere meter pans and fused disconnect switches rated for 120/208 volt, 3 phase, 4 wire shall be furnished, installed and wired for the above.

C. The limited availability of open space at the site may require relocation of the temporary electrical system components, in order to support construction related activities. The Contractor shall include in his lump sum price bid six complete relocations of the entire temporary electrical system, including service entrance and distribution center equipment.

1.7 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer and the utility in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:

1. One line diagram representing the power distribution for the temporary system.
2. Location plan indicating the major distribution equipment.
3. Manufacturer's catalog cuts for the products proposed for use.
4. Panel loading, voltage drop, short circuit and lighting calculations.
5. Security lighting layout with photometric and footcandle printout.

1.8 QUALITY ASSURANCE

A. The temporary general lighting system shall provide lighting for access to and egress from the work and for safe and expeditious construction within designated enclosed areas of the structure or structures.

B. All temporary electrical system equipment and components shall be of recent manufacture and of proper working order for the intended purpose.

C. The Contractor shall maintain in proper working order and repair the temporary electrical system. All costs for maintenance of the system shall be in accordance with the Specifications.

The Contractor shall modify, extend, and relocate the temporary electrical system components, as needed or as directed by the Engineer, to support construction activities

E. The Contractor shall remove the temporary electrical system when directed by the Engineer. All costs for removal of the system shall be included in the lump sum price bid. Where additional facilities were required by other Subcontractors (as specified in 1.05G hereinbefore), removal thereof shall be at their own expense.

1.9 DELIVERY, STORAGE AND HANDLING

A. The temporary electrical equipment shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 ELECTRICAL SERVICE CONNECTION

A. The Contractor shall provide a service entrance and distribution center at the service

point. Service entrance and distribution equipment shall be in accordance with the following:

1. Enclosures shall be rated NEMA 3R.
2. Meter pans shall be suitable for revenue meters.
3. Circuit breakers shall be thermal magnetic type. Circuit breakers shall be equipped with lockable handles.
4. Disconnect switches shall be fused type with current limiting fuses. Disconnect switches shall be equipped with padlocking features.
5. For the Contractor's staging area located in the northwest area of the site, power shall originate from a spare breaker compartment in USS 5 as identified by the Resident Engineer. Contractor shall furnish and install all poles, cables, messenger cable, and supports required for the routing of temporary power.
6. All equipment shall be approved by the Engineer.

B. The Contractor shall also provide the following other equipment at the service point:

1. 8 foot high, steel chain link fence with gate shall enclose the service entrance and distribution center. The fence shall be arranged so to permit a minimum clearance distance of 6 feet between the fence and the equipment.
2. The fence shall include baked enamel, 14 by 10 inch caution signs. The signs shall read, "DANGER - HIGH VOLTAGE - KEEP - OUT". The signs shall be bolted to the fence on each side of the fence and on the main gate.
3. A 4/0 AWG ground grid consisting of four ground rods, one at each corner, shall be provided. Maximum ground resistance shall be 10 ohms. Grounding shall be in accordance with Article 2.4.

2.2 RACEWAYS AND WIRING

A. All conductors shall be 600 volt, enclosed in properly sized raceways or be routed aerially using Type AC, MC or TC cable.

B. Conductors shall be provided for all devices, suitably sized for the intended purpose. Conductors installed in raceways shall be single conductor type THHN/THWN or equal to be approved by the Engineer. Armored cable, Type AC, metal-clad cable, Type MC or power and control tray cable, Type TC shall also be permitted.

C. Raceways where used shall be suitably sized for the conductors. Raceways shall be rigid metallic type.

D. Aerially routed cables shall be messenger supported from solid wood poles or other recognized means. Messenger shall be high strength galvanized steel.

E. Poles shall have a class suitable for the installation in accordance with the National Electrical Safety Code and shall be thirty feet length minimum. Poles shall be guyed at angle or corner runs and when eccentrically loaded.

2.3 LIGHTING FIXTURES AND DEVICES

A. Receptacles (GFI type) shall be grounded type, 120 volt, 20 ampere suitable for hand tools such as drills, hammers and grinders.

B. General lighting lamps shall be 100 watt installed in suitable lamp holders. Security lighting lamps shall be 400 watt high pressure sodium installed within a floodlight type fixture suitable to illuminate the intended area.

C. Switches, breakers and miscellaneous equipment shall be suitable for the intended purpose, with voltage, current and short circuit interrupting ratings as required for the circuits.

2.4 GROUNDING

A. The temporary systems shall be grounded in accordance with the requirements of Specification 16061 - Grounding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Temporary wiring systems shall be installed without interfering with the work of other Contractors.

B. The ground grid cable shall be installed in loop fashion completely around and outside the service point fence. The fence and distribution equipment shall be connected to the grid at a minimum of two locations.

C. The temporary general lighting system shall be installed progressively in structures as the designated areas are enclosed or as lighting becomes necessary because of partial enclosure. Lamps shall be installed to provide an even distribution of illumination over the work areas.

D. Receptacles shall be installed in such a manner so as to reach any point in the work areas with an extension cord not to exceed 40 feet in length.

E. Security lighting shall be installed on poles to illuminate the staging and parking areas.

F. Aerial conductors shall be installed at a minimum height of 14 feet above finished grade. When conductors cannot be routed at the proper height or where it will interfere with plant operations or construction activities, conductors shall be provided in rigid steel conduit and installed underground.

3.2 OPERATION

A. The Contractor shall keep the temporary power and lighting system alive each working day from 6:00 A.M. to 6:00 P.M., from Monday to Friday inclusive.

B. Any Contractor requiring the use of the temporary electrical facilities before 6:00 A.M. or after 6:00 P.M., from Monday through Friday or at any time on Saturdays, Sundays or holidays, shall bear the cost of energizing and/or de-energizing the system. If more than one Contractor uses the system during such periods, the cost thereof shall be prorated among each Contractor.

3.03 MAINTENANCE

A. The temporary electrical system shall be maintained and repaired until it is no longer required.

B. Lamps, fuses and other equipment shall be repaired and/or replaced, as required.

3.4 REMOVAL

A. At the conclusion of the work, when directed by the Engineer, the temporary system shall be removed in its entirety. The ground surfaces and structures disturbed by the work shall be restored to their original condition.

++ END OF SECTION + +

NO TEXT ON THIS PAGE

SECTION 16035

DEMOLITION ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing demolition work. This section also includes equipment relocation. The demolition and relocation work shall be performed in accordance with the requirements specified under this Section, the Specifications and the Contract Drawings.

B. The Contractor shall remove and dispose of all electrical equipment and items as a result of the demolition Work. Where demolished equipment is so identified, it shall become the property of the County and disposal shall not occur.

C. The Contractor shall also relocate electrical equipment. The extent of the demolition and relocation work is shown on the Contract Drawings.

1.2 PAYMENT

A. Payment for demolition work shall be made as provided for in the Specifications.

1.3 REFERENCES

A. Demolition work shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. Local Codes and Ordinances

1.4 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Techniques and details proposed to accomplish the demolition work.

1.5 QUALITY ASSURANCE

A. All demolition and removal work shall be in accordance with the Nassau County Building Code and NFPA 70 National Electrical Code.

B. In performance of the demolition work, the Contractor shall provide protection of adjacent plant areas, existing equipment and on-going construction. No electrical equipment shall be disposed off-site without the written approval of the County and Engineer.

C. The Contractor shall execute the work in a careful and safe manner with the least possible disturbance to the public and to the operation of the facility. All work shall be performed with due regard to maintenance of plant operations and construction staging in accordance with the Specifications.

D. Demolition and removal work shall be executed with care and performed by competent experienced workmen for the various types of demolition and removal work. All patching, replacing and refinishing of work shall be done by skilled workmen. The work shall be carried out through to completion with due regard to the safety of County employees, workmen on site and the public.

E. The Contractor shall make such investigations, explorations and probes as are necessary to ascertain any required protective measures before proceeding with demolition and removal. The Contractor shall give particular attention to shoring, bracing and shielding requirements so as to prevent any damage to new or existing construction. The Contractor shall be responsible for any damage which may be caused by demolition and removal work to any part or parts of existing structures or equipment designated for reuse or to remain.

F. All demolished equipment becomes the property of the Contractor, except where identified by the County. All equipment marked by the County to remain shall be carefully removed by the Contractor, so as not to be damaged, cleaned and stored on or adjacent to the site in a protected place or loaded onto trucks provided by the County.

G. The Contractor shall coordinate with other Prime Contractors to disconnect or remove sources of power to equipment being removed or relocated under other Contracts.

1.6 SITE CONDITIONS

A. The County assumes no responsibility for the actual condition of structures to be demolished and removed. Conditions existing at the time of inspection for

bidding purposes shall be noted by the Contractor and shall be used by him in preparing his bid.

B. The Contractor shall perform the work with due regard that certain equipment, tanks, and piping contain gases which are potentially hazardous and may be toxic, contain insufficient oxygen for human survival and are combustible in the presence of oxygen. All work regarding hazardous materials shall be performed in accordance with the Specifications.

C. The Contractor shall perform the work with due regard that in some areas only certain systems and equipment shall be demolished while other systems and equipment shall remain operational. Contractor shall field determine and make such investigations as required to determine the source and function of each circuit, to allow for the disconnection and removal each circuit not required as result of the demolition and to retain all active circuits for areas unaffected by the demolition work.

1.7 SCHEDULING

A. The Contractor shall proceed with the demolition and removal of equipment in a sequence designed to maintain the existing facility in operation. The Contractor shall notify the Engineer 48 hours before proceeding and meet with plant personnel to review removals and demolition work. Work shall begin only after approval of the County and Engineer.

B. Any equipment and appurtenances removed without proper authorization, which are necessary for the operation of the existing facility, shall be replaced to the satisfaction of the Engineer at no cost to the County.

C. The Contractor shall familiarize himself with the work of all contracts and coordinate and schedule demolition activities with the other Prime Contractors for proper sequencing of the work and the removal of equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. The Contractor shall provide protection and restoration of structures in accordance with the Specifications. Catch platforms, lights, barriers, weather protection, warning signs and other items shall be provided as required for proper protection of the public, occupants of the building, workmen engaged in demolition operations, and adjacent construction.

B. The Contractor shall provide weather protection at exterior openings so as to fully protect the interior premises against damage from the elements until such openings are closed by new construction.

C. The Contractor shall provide temporary protection of the existing structure designated to remain where demolition, removal and new work is being done, connections made, materials handled or equipment moved.

D. The Contractor shall provide dustproof partitions to prevent dust from rising by wetting demolished masonry, concrete, plaster and similar debris. Unaltered portions of the existing equipment affected by the demolition shall be protected. Such enclosures will be required in areas of major demolition work and for protection of existing equipment and personnel. Insulating barriers shall also be provided where necessary for protection.
   1. Dust proof partitions shall be constructed of wood studs with plywood on both sides. Partitions shall extend from floor to ceiling with a closure plate at the floor and ceiling and a dust- tight door in each enclosure complete with hardware, attached and keyed.
   2. Insulation barriers shall be provided to cover exposed, energized terminals, wires and busses.
   3. Adequate ventilation shall be provided for a safe working environment.

E. The Contractor shall provide adequate fire protection during demolition in accordance with East Rockaway Fire Department requirements.

F. The Contractor shall not close or obstruct roadways, walkways, passageways, or stairways and shall not store or place materials in passageways, stairs or other means of egress. The Contractor shall conduct operations with minimum traffic interference.

G. The Contractor shall repair any damage to the existing structure or contents by reason of the insufficiency of protection provided.

3.2 REMOVALS

A. The Contractor shall demolish or relocate electrical equipment as shown on the Contract Drawings. All motors shall be disconnected by the Contractor, but removed with the driven equipment by the other Subcontractors.

B. All wiring shall be removed, salvaged and stored. Direct burial cable shall be abandoned, but disconnected at both ends, insulated and identified. Where cable enters a structure, the cable shall be cut back to the point of entrance.

C. All exposed conduits shall be removed and disposed. Conduits underground or concealed shall be abandoned. Abandoned conduits shall be cut flush with the slab or wall at the point of entrance and plugged.

D. Recessed equipment to be demolished shall be abandoned, unless otherwise noted on the Contract Drawings. Demolished recessed panelboards and boxes enclosure fronts and internals shall be completely removed. The enclosure fronts shall be covered with new blank cover plates.

E. Wherever cable and conduit are to be removed for disposition, the circuit shall be de-energized by the Contractor and adjacent circuits that are to remain in service shall be blanked off and then isolated.

F. All supports, pedestals and anchors for conduits, lighting fixtures and other equipment shall be removed with the equipment unless otherwise noted on the Contract Drawings. Concrete bases, anchor bolts and other supports shall be removed to approximately one inch below the surrounding finished area and the recesses shall be patched to match the adjacent areas.

G. The Contractor shall dispose of all demolition equipment, debris and other items, not marked by the County to remain, off the site and in conformance with all applicable codes and regulations.

H. The Contractor shall perform patching, restoration, finishing and new work in accordance with the Specifications. All openings in structures as a result of the work, shall be patched and exterior openings made watertight. Where alterations occur, or new and old work join, the Contractor shall cut, remove, redrill or refinish the adjacent surfaces to the extent required by the conditions, so to leave the altered work in a condition as existed prior to the start of the work.

I. Superstructure wall and roof openings shall be closed, and damaged surfaces shall be restored to match the adjacent areas. Wall sleeves and castings shall be plugged or blanked off, all conduit openings in equipment shall be closed.

J. Where equipment is indicated to be removed, relocated and reused, the equipment shall be operated in the presence of representatives of the Contractor, and the Engineer. Such items shall be removed or relocated with care to prevent unnecessary damage, under the supervision of the trade responsible for reinstallation and protected and stored until required. Material or items damaged during removal shall be replaced with similar new material or items.

3.3 CLEANING AND MAINTENANCE

A. The Contractor shall maintain the existing electrical power system to operate without interruption. Any interruption of electrical power to the existing facility

and equipment shall be with the approval and permission of the County and the Engineer.

B. The Contractor shall maintain all protection facilities installed in preparation of the demolition work.

C. The Contractor shall provide on-site dump containers for collection of waste materials, debris and rubbish.

D. All existing surfaces shall be cleaned of dirt, grease, loose paint before refinishing.

E. The Contractor shall clean the site and properties of dust, dirt and debris caused by the demolition and removal work in accordance with the Specifications. Waste materials, debris and rubbish shall be disposed of and the areas shall be returned to conditions prior to start of the work.

+ + END OF SECTION + +

SECTION 16036

TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The Contractor shall perform all tests as specified in these specifications, and as required.

B. Individual testing requirements are detailed in the individual equipment specifications.

1.2 RELATED SPECIFICATIONS

A. Specification 16261 – Uninterruptible Power System
B. Specification 16271 – Dry Type Transformers
C. Specification 16292 - Power Distribution System Coordination
D. Specification 16293 – Medium Voltage Metal-Clad Switchgear
E. Specification 16294 – Medium Voltage Solid State Starters
F. Specification 16322 – Cast Coil Transformers
G. Specification 16430 – Low Voltage Switchgear
H. Specification 16441 – Panelboards
I. Specification 16442 – Electrical Control Equipment Low Voltage AC Motors and Devices
J. Specification 16482 – Motor Control Centers
K. Specification 16496 – Automatic Transfer Switches

1.3 REFERENCES

A. NETA - International Electrical Testing Association.

B. IEEE - Institute of Electrical and Electronics Engineers.

C. ANSI - American National Standards Institute.

1.4 DESIGN REQUIREMENTS

A. General
   1. The Contractor shall furnish all instruments and qualified personnel for all tests.

2. Written notice of all tests shall be given to the Engineer at least two (2) weeks in advance.
3. Unless waived in writing by the Engineer, all tests shall be made in the presence of a duly authorized representative of the Engineer. When the presence of such representative is so waived, sworn statements, in duplicate, of the tests made and the results thereof, shall be furnished to the Engineer by the Contractor.
4. Necessary adjustments and testing shall be made in cooperation with the respective manufacturers and other Contractors when necessary.
5. The Contractor shall make available, the electrical system and personnel when required by other Contractors to test their respective equipment. The Contractor shall coordinate their resources with the other Contractors.

B. Factory and witness shop testing requirements shall be as detailed in the individual equipment specifications.

C. Field Testing:
1. All electrical equipment furnished, installed or modified under this Contract shall be field tested by this Contractor as detailed in the individual equipment specifications.

D. Schedules and Plant Operations
1. When testing requires that certain pieces of equipment be taken out of service, all testing procedures and schedules must be submitted to the County's engineer for review and approval one month prior to any work beginning. When testing has been scheduled as above, the plant must be notified 48 hours prior to any work to allow time for load switching and/or alternation of equipment. In addition, all testing that requires temporary shutdown of plant equipment must be coordinated with plant personnel so as not to affect proper plant operations.
2. At the end of the workday, all equipment shall be back in place and ready for immediate use should a plant emergency arise. In addition, should an emergency condition occur during testing, at the request of the plant engineer, the equipment shall be placed back in service immediately and turned over to plant personnel.
3. In the event of accidental shutdown of plant equipment the contractor shall notify plant personnel immediately to allow for an orderly restart of affected equipment.

E. Independent Testing: In addition to the independent testing for the short circuit and relay coordination studies and relay setting and protective device settings (as described in Specification 16292 - Power Distribution System Coordination), all medium voltage equipment testing, including medium voltage cable tests,

shall be performed by a qualified testing company using NETA certified technicians.

F. Final Field Testing
   1. The Contractor shall complete the installation and testing of the electrical installation at least two (2) months prior to the start-up and testing of all other contracts. During the period between the completion of electrical installation and the start-up and testing of all other contracts, the Contractor shall make all components of the Electrical Work available to the other contractors as it is completed for their use in performing Preliminary and Final Field Tests.
   2. Before each test commences, the Contractor shall submit a detailed test procedure, and also provide manpower and scheduling for the approval of the Engineer. In addition the Contractor shall furnish detailed test procedures for any of his equipment required as part of the field tests of systems by other contractors.

1.5 SUBMITTALS

A. Submit the following in accordance with Article GC-14 of the General Conditions and Division 1.

B. Certificate of Compliance
   1. Qualifications of independent testing firm and technicians.

C. Reports
   1. Proposed testing methods and schedules.

   2. All field test reports.

1.06 QUALITY ASSURANCE AND QUALIFICATIONS

A. As detailed above, the independent testing firm shall be a qualified firm employing NETA certified technicians.

+ + END OF SECTION + +

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SECTION 16061

GROUNDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing grounding. Grounding shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The grounding work shall be a complete system for the electrical and instrumentation systems, structures and equipment. The work shall include grounding of all electrical equipment, transformer neutrals, equipment enclosures, grounding electrodes, fences and gates.

1.2 RELATED SPECIFICATIONS

A. Specification 16121 - Electric Wires and Cables

B. Specification 16131 - Electric Conduit System

1.3 PAYMENT

A. Payment for grounding shall be made as provided for in the Specifications.

1.4 REFERENCES

A. Grounding shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. Long Island Power Authority.
   3. UL Standard No. 467, Electrical Grounding and Bonding Equipment.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:

1. Prior to equipment submission, submit a list of proposed manufacturers with the products they produce proposed for the contract.
2. Manufacturer's catalog cuts for the grounding materials proposed for use.
3. Scaled working drawings showing proposed routing and layout of the grounding system.

C. Field test report shall be submitted.

1.6 QUALITY ASSURANCE

A. The grounding system maximum resistance shall not exceed 5 ohms under normally dry conditions. All structures and metal equipment containing electrical apparatus shall be connected to ground.

B. All grounding associated with the Long Island Power Authority service feeders shall be in accordance with the requirements of Long Island Power Authority.

1.7 DELIVERY, STORAGE AND HANDLING

A. The grounding equipment shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 GROUND CABLE

A. The ground cable shall be soft drawn bare stranded copper conforming to ASTM B8 and B189. Size shall be as stated in 16900 Cable and Conduit Schedule and as shown on the Contract Drawings.

B. The insulated cable for equipment grounding shall conform to the requirements of Specification 16121 - Electric Wires and Cables.

C. Ground cable shall be General Cable Corporation, Okonite Cable Company or equal to be approved by the Engineer.

2.2 GROUND RODS

A. Ground rods shall be copper-clad steel, 5/8-inch diameter and 10 feet long.

B. Ground rods shall have a drive point at the lower ends. The upper end of each rod shall be equipped with bronze, clamp type connectors with not less than four bolts.

C. Ground rods shall be Heary Brothers Lightning Protection Company, Fushi Copperweld, or equal to be approved by the Engineer.

2.3 GROUNDING CONNECTORS

A. Compression connectors shall be heavy duty copper. Bolted connectors shall be copper alloy castings, designed specifically for the items to be connected, and assembled with Durium or silicone bronze bolts, nuts and washers.

B. Welded connections shall be by exothermic process utilizing molds, cartridges and hardware designed specifically for the connection to be made.

C. Bolted or compression grounding connectors shall be Burndy, Thomas and Betts or equal to be approved by the Engineer. Welded grounding connections shall be Cadwell or equal to be approved by the Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. A complete ground grid system shall be installed as shown on the Contract Drawings.

B. Ground cable shall be installed around perimeter of structures at a minimum of 2 feet-6-inches below grade.

C. Ground rods shall be installed 2 feet below grade, 2 feet from foundation walls and shall extend 10 feet vertically into the earth.

D. Test points shall be installed at locations and in accordance with the details shown on the Contract Drawings.

E. Equipment shall be connected in accordance with the details shown on the Contract Drawings. All steel column and underground connections shall be welded except for test points.

F. Metal casings or supporting frames of electrical equipment, such as transformers, panel boards, control panels, unit substations, and individual

motor controllers shall be grounded. The equipment shall be thoroughly grounded to the facility grounding system. All metal conduits leaving all electrical equipment shall be grounded. Grounding type fittings shall be installed on flexible conduits.

G. An insulated cable for equipment grounding shall be installed with the phase conductors within the conduit for the nominal 120 volt and higher power, lighting and control circuits.

3.2 FIELD TESTING

A. After installation, the completed ground system shall be field tested for operation and conformance. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide testing consisting of the following:
   1. Resistance testing shall be made using a Biddle, Null Balance Earth Tester or Associated Research Vibro-ground, not less than 48 hours after rainfall. Resistance shall be no more than 5 ohms. If resistance is greater than 5 ohms, the Contractor shall continue to drive ground rods up to a maximum of three to reduce the resistance to 5 ohms. Resistance values above 5 ohms after three ground rods have been driven in the same area shall be brought to the Engineer's attention.
   2. Grounded cables and metal parts shall be continuity tested. The conduit system shall be ground tested in accordance with the requirements of Specification 16131 - Electric Conduit System.

B. The Contractor shall provide a Field Test Report, the report shall identify the testing performed and the results obtained.

+ + END OF SECTION + +

SECTION 16071

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing supporting devices. Supporting devices shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The supporting devices shall be a complete system for the equipment. The work shall include providing all required support devices to properly mount and secure all equipment furnished under this Contract.

C. This section also includes equipment anchorage and restraints suitable to meet the specified seismic requirements.

1.2 RELATED SPECIFICATIONS

A. Specification 16131 - Electric Conduit System

1.3 PAYMENT

A. Payment for supporting devices shall be made as provided for in the Specifications.

1.4 REFERENCES

A. Supporting devices shall comply with the latest applicable provisions and recommendations of the following:
   1. ASTM A569, Specification for Steel, Carbon, Hot-Rolled Sheet and Strip Commercial Quality.
   2. ASTM A570, Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
   3. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   4. AISI, Standard for Stainless Steel.
   5. MFMA-1, Standard Publication for Metal Framing.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Manufacturer's catalog cuts for the supporting devices proposed for use with specifications and other data required to demonstrate compliance with the specified requirements.
   2. Scaled working drawings showing dimensions and locations of all items and clearance requirements.
   3. Support design details and equipment seismic anchorage and restraint details, stamped by a licensed Engineer as required.

C. Contractor is responsible for retaining a New York State Registered engineer to design the hanger systems to support the electrical raceways. Contractor shall submit a signed and sealed shop drawing along with calculations for review and approval by the engineer of record.

1.6 QUALITY ASSURANCE

A. General:
   1. All channels, fittings and hardware used in the supporting system shall be in accordance with MFMA-1, Standard Publication.
   2. The design of the support system shall be the responsibility of the Contractor. The Contractor shall provide the proper sized rods, channels, fittings, brackets and appurtenances necessary to adequately support the equipment.
   3. The Contractor shall retain the services of a Licensed Engineer, registered in the State of New York, to prepare support details for equipment exceeding 50 pounds in weight. The Engineer shall stamp the support system design details.

B. Seismic Requirements:
   1. Equipment assemblies such as secondary unit substations, switchgear, motor control centers and panelboards shall be certified to meet seismic requirements in accordance with the requirements specified in the applicable sections of the Specifications.
   2. The Contractor shall be provide equipment anchorage details for all equipment certified to meet seismic requirements. The details shall be coordinated with the manufacturer's equipment mounting provisions.

3. Electric conduit shall include seismic restraints in accordance with the requirements of Specification 16131 - Electric Conduit System.
4. The Contractor shall retain the services of a Licensed Engineer, registered in the State of New York, to prepare the seismic anchorage and restraint details. The Engineer shall stamp the seismic anchorage and restraint details.

1.7 DELIVERY, STORAGE AND HANDLING

A. The supporting devices shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Supporting devices shall be by B-Line (Eaton), Kindorf (Thomas & Betts/ ABB Group) or equal to be approved by the Engineer.

2.2 CHANNELS, FITTINGS AND BRACKETS

A. The Contractor shall provide channels, fittings, brackets and related hardware for mounting and supporting the electrical equipment. Anchor bolts, concrete inserts and related hardware for proper support of equipment shall also be provided. All equipment necessary to meet the seismic requirements specified shall be provided.

B. Channels shall conform to ASTM A569 or A570. Channels shall have a minimum thickness of 12 gauge. The cross sectional width dimension shall be 1-1/2 inch minimum. The depth shall be as required to satisfy load requirements.

C. Attachment holes, when required, shall be factory punched on hole centers approximately equal to the cross sectional width and shall be 9/16 inch diameter.

D. Fittings and brackets shall have 9/16 inch diameter holes on centers identical to the channel or as required to align with the channel holes. Fittings and brackets shall have the same width as the channel and shall be 1/4 inch thick minimum. Fittings and brackets shall mate properly with the channel.

E. All channels, fittings, brackets and related hardware shall be steel and have an electro-plated zinc finish according to ASTM B633.

F. In corrosive areas, channels, fittings, brackets and related hardware shall be type 316 stainless steel or PVC coated.

2.3 CONDUIT HANGERS, SUPPORTS AND INSERTS

A. The Contractor shall provide channels, rods, straps, anchors and related hardware for support of the exposed electric conduit system.

B. The Contractor shall also provide anchor bolts, concrete inserts and related hardware for proper support of equipment. All equipment necessary to meet the seismic requirements specified shall be provided.

C. Conduit hangers, supports and inserts shall be in accordance with Specification 16131 - Electric Conduit System.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All supporting devices shall be installed level, parallel and perpendicular to building walls and floors, such that the support system is installed in a neat and professional manner.

B. All holes in hung ceilings for support rods and other equipment shall be made adjacent to bars where possible, to facilitate removal of ceiling panels.

C. The channels, fittings and brackets shall be rigidly bolted together and braced to make a substantial supporting framework support system.

D. Where motor control centers, switchgear, unit substations and other electrical equipment is being installed on concrete pads, the Contractor shall furnish leveling channels. The Contractor shall install the leveling channel in the concrete pads. Seismic certified equipment shall be anchored in accordance with the seismic anchorage details.

E. All equipment fastenings to steel columns, beams and trusses shall be by beam clamps. In lieu of beam clamps, equipment may be welded to steel structures, subject to Engineer approval.

F. No holes shall be drilled in any steel columns, beams and trusses.

G. Hanger rod supports shall be installed such that threaded rod is parallel and perpendicular to building walls and floors.

+ + END OF SECTION + +

NO TEXT ON THIS PAGE

SECTION 16076

LABELING AND IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing labeling and identification. Labeling and identification shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The labeling and identification shall be provided for the identification of equipment. The work shall include providing all high voltage signs, equipment nameplates, markers and tags for all equipment furnished under this Contract.

C. The Contractor is advised that the equipment identification shown on the Contract Drawings is temporary and will be finalized during construction.

D. Temporary identification will be required as to information specified, but only final identification needs to conform to materials and mounting methods specified herein.

E. All switchgear, unit substation, motor control center nameplates shall have both the equipment name and tag identification number.

F. All pullboxes, junction boxes, terminal boxes, etc. shall be tagged with its own unique system related tag number.

G. All conduits shall be tagged with its own unique system related tag number. The conduit systems include, but are not limited to, power, lighting, telephone, instrumentation, process/mechanical, fire alarm, low voltage power, security, CCTV, and Fiber Optic Network.

H. In addition to tagging and labeling the pullbox exterior, the pullbox interior shall also be tagged and labeled. All conduit bushings on the pullbox interior shall be tagged and labeled.

1.2 RELATED SPECIFICATIONS

A. Specification 16121 - Electric Wire and Cable

B. Specification 16131 - Electric Conduit System

1.3 PAYMENT

A. Payment for labeling and identification shall be made as provided for in Division 1 of the Specifications.

1.4 REFERENCES

A. Labeling and identification shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. OSHA, Occupational Safety and Health Act.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Prior to equipment submission, submit a list of proposed manufacturers with the products they produce proposed for the contract.
   2. Submit signs, nameplates and other labeling and identification devices proposed for use with specifications and other data required to demonstrate compliance with the specified requirements.

1.6 QUALITY ASSURANCE

A. All labeling and identification signs and nameplates shall be provided in accordance with the NFPA 70 and OSHA.

1.7 DELIVERY, STORAGE AND HANDLING

A. The labeling and identification devices shall be delivered, stored and handled in accordance with the Specifications and the manufacturer’s recommendations.

PART 2 - PRODUCTS

2.1 HIGH VOLTAGE SIGNS

A. High voltage signs shall be provided for equipment operating over 600 volts.

B. High voltage signs shall be fiberglass reinforced polyester, rigid acrylic or aluminum plate 1/16-inch thick. Finish shall be industry standard of red, white and black graphics. Signs shall be 10 inches by 14 inches with the following exceptions:
   1. Use 7-inch by 10-inch signs where this is the largest size that can be applied.
   2. Use 14-inch by 20-inch signs where needed for adequate vision.

C. High voltage signs shall read; "DANGER - HIGH VOLTAGE KEEP OUT".

D. High voltage sign mounting screws shall be 3/16 inch diameter, round head, stainless steel, self-tapping type.

2.2 EQUIPMENT NAMEPLATES

A. Equipment nameplates shall be provided in addition to the manufacturer's nameplate, to identify the equipment number and the item's function and the equipment to which it serves.

B. Equipment nameplates shall be provided in accordance with the requirements specified under Article 2.02 and Specification 15076 - Piping and Equipment Identification.

C. Equipment nameplates shall be laminated plastic with black letters on a white background. Nameplates for equipment identification shall have 1/2-inch high letter engravings. Nameplates for pilot device identification shall have 1/4-inch high letter engravings.

D. Nameplates for distribution equipment shall have the following information:
   1. Equipment name and number.
   2. Voltage.
   3. Phases and number of wires.

E. Pullboxes, junction boxes and control stations shall have a nameplate identifying the equipment name and number.

F. All feeders and branch circuit devices shall have nameplates identifying the served equipment name and number. Where execution of the work under this Contract requires certain feeders and branch circuit devices to be modified, the Contractor shall provide new nameplates reflecting the modifications. The nameplates shall identifying the served equipment name and number.

G. All control and indicating devices shall have individual nameplates identifying device function.

H. Nameplate mounting screws shall be 3/16 inch diameter, round-head, stainless steel self-tapping type. Adhesives shall not be used.

2.3 CONDUIT MARKERS AND TAGS

A. Conduit markers and tags shall be provided for the identification of the electric conduit system.

B. Conduit markers and tags shall be in accordance with Specification 16131 - Electric Conduit System.

2.4 CABLE AND WIRE MARKERS

A. Cable and wire markers shall be provided for the identification of the electric wire and cable.

B. Cable and wire markers shall be fiberglass based. Teflon coated stainless steel line/wire shall be used to attach the markers to the cables.

C. Cable and wire markers shall be in accordance with Specification 16121 - Electric Wire and Cable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All signs, nameplates and tags shall be installed neatly, properly and as recommended by the manufacturers.

B. Signs and nameplates shall be mounted with screws. Where mounting of signs or nameplates with screws is impractical, the Contractor shall alert the Engineer.

C. High voltage signs shall be installed on equipment operating at over 600 volts. High voltage signs shall also be installed on sides of fences or walls which enclose outdoor equipment operating at over 600 volts.

D. Control, signal and status wire and cable shall be identified by a unique number. The numbering system shall reflect the actual identification used in the work and shall be documented on the point-to-point wiring diagrams.

+ + END OF SECTION + +

SECTION 16121

ELECTRIC WIRES AND CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing electric wires and cables. Electric wires and cables shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The electric wires and cables to be provided shall include all accessories.

C. The following index of this Specification is presented for convenience.

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D. The cables and wires proposed for all instrumentation cables and wires shall be approved by the Contractor before Engineer approval can be given. The Contractor shall submit the approvals from the Contractor along with the cable and wire shop drawings for Engineer approval. The cable and wires shall include those used for all equipment and devices specified in Division 15.

1.2 PAYMENT

A. Payment for electric wires and cables shall be made as provided for in Division 1 of the Specifications.

1.3 REFERENCES

A. Electric wires and cables shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. National Electrical Safety Code.
   3. ASTM B5, High Conductivity Tough-Pitch Copper Refinery Shapes.
   4. ASTM B8, Concentric-Lay-Stranded Copper Conductors, Hard, Medium-hard or Soft.
   5. ASTM B33, Tin Coated Conductors.
   6. ASTM D69, Test Methods for Friction Tape
   7. ICEA S-66-524 Cross-linked-thermosetting - polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical energy.
   8. ICEA S-68-516, Ethylene-Propylene-Rubber-Insulated Wire and Cable for Transmission and Distribution of Electrical Energy.
   9. UL Standard No. 44, Wires and Cables, Rubber-Insulated.
   10. UL Standard No. 83, Wires and Cables, Thermoplastic-Insulated.
   11. UL Standard 486A - Wire Connectors and Soldering Lugs for Use With Copper Conductors.
   12. UL 1072, Medium Voltage Power Cables.
   13. AEIC CS6-87, Ethylene-Propylene-Rubber-Insulated Shielded Power Cable.
   14. NETA, International Electrical Testing Association.
   15. IEEE 48, Test Procedures and Requirements for High Voltage Alternating-Current Cable Terminations.

1.4 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Prior to equipment submission, a list of proposed manufacturers shall be submitted with the products they produce proposed for the contract.
   2. Manufacturer's Literature, specifications and engineering data for the electric wires and cables and accessories.
   3. For medium voltage wires and cables the following information shall be submitted:
      a. Manufacturer and type of cable.
      b. Minimum insulation resistance in megohms per 1,000 ft. At 15.5 degrees C.
      c. Material, number and size of strands composing each conductor.
      d. Conductor insulation in thickness inches or 64th of an inch with material and voltage rating.
      e. Sheath thickness in inches or 64th of an inch.
      f. Average outside diameter of bare conductor.
      g. Average outside diameter of finished cable and jacket material.
      h. Weight per 1,000 ft. of finished cable.
      i. Material and thickness in inches or 64th of an inch of each shield system.
      j. Minimum bending radius, in inches.
      k. Minimum pulling temperatures at which cable may be pulled without damage.
      l. Maximum pulling tensions which may be applied to the cable without damage.
      m. Literature identifying the methods and materials which Contractor proposes to use to make splices and terminations. Submittal shall consist of manufacturer's literature evidencing compatibility of the conductor insulation, shield and jacket of the cable with the splicing or terminating materials and methods which Contractor proposes to use.
      n. Manufacturer's recommended pulling lubricants.
      o. Qualifications of splicing and termination personnel.
   4. Description of shop and field testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least 45 days in advance prior to conformation of witness testing dates and actual testing.

5. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least 45 days in advance to actual testing, five recent references with phone numbers shall be submitted.

6. Qualifications of proposed mineral-insulated metal sheath cable installer shall be submitted. Submit installer experience records with five recent completed installations with names and phone numbers.
7. Certification from the mineral-insulated metal sheath cable manufacturer's representative that the cable installation is in accordance with the manufacturer's requirements.

C. Reports:
   1. Shop and field test reports shall be submitted.
   2. Acceptance testing report shall be submitted.

D. MATERIAL SAFETY DATA SHEETS
   1. Material Safety and Data Sheets (MSDS) shall be submitted for all cables and wires supplied. MSDS shall be submitted with the equipment shop drawings.

1.5 QUALITY ASSURANCE

A. General:
   1. All cables and wires shall be made by an approved manufacturer, and in their construction shall be employed the most improved commercial materials and processes of manufacture.
   2. Only electrical wiring manufactured under high standards of production and meeting the approval of the Engineer shall be used. Friction tape shall be in accordance with ASTM Des. D69.
   3. All medium voltage cable splicing and terminations shall be done by experienced cable splicers who have worked with similar cable for a period of at least 10 years, using materials and procedures recommended by the cable manufacturer. All splicing and terminations of medium voltage cable shall be in accordance with the instructions of the cable manufacturer.
   4. The wire and cable manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all shop tests. Calibration of testing apparatus shall be within one year.

5. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology and the NETA acceptance testing specification.
6. The mineral-insulated metal sheath cable installation shall be performed by experienced mineral-insulated metal sheath cable installers who shall have been regularly engaged in the installation of mineral-insulated metal sheath cable for a minimum of the past three years.

7. The Contractor shall retain the services of the mineral-insulated metal sheath cable manufacturer's representative to certify the cable installation is in accordance with the manufacturer's requirements.

B. Field Tests:
1. Electric wires and cables shall be field tested. Field testing for 600 volt and below wires and cables shall be in accordance with the requirements specified under Article 3.4.
2. The Contractor shall retain the services of an independent testing firm who shall perform acceptance testing on the medium voltage wire and cable installation. The testing firm shall have experience in the inspection and testing of cables of the type specified and shall be a member company of NETA. Provide proof of membership or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer. The testing shall be performed in accordance with the requirements specified under Article 3.5.

1.6 DELIVERY, STORAGE AND HANDLING

A. Electric wires and cables shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's instructions.

PART 2 - PRODUCTS

2.1 300 VOLT INSULATED CABLE

A. 300 volt insulated cable shall be used for all instrumentation and communication circuits. The size and quantity of 300 volt insulated cable shall be as indicated in the conduit and cable schedule.

B. Instrumentation cable shall be in accordance with the following:
1. Conductors shall be stranded, tinned coated copper, No. 16 AWG minimum size. All conductors shall be polyethylene insulated and twisted in pairs with an aluminum-mylar shield overlapped.

2. The cable shall include an outer jacket. Jacketing shall be neoprene, chlorosulfonated polyethylene (hypalon), chlorinated polyethylene or flame retardant 105 degree C polyvinyl chloride.
3. Instrumentation cable shall be by Okonite Company, General Cable Corporation, Belden Company or equal to be approved by the Engineer.

C. Communication and Fire Alarm Cable shall be in accordance with the following:

1. Conductors shall be stranded, tinned coated copper, No. 18 AWG minimum size for fire alarm cable and No. 24 AWG for communication cable. Insulation shall be polyethylene. Where specifically shown on the Contract Drawings or stated in the Specifications, communication system conductors shall be twisted shielded cable.
2. The cable shall include an outer jacket. Jacketing shall be neoprene, chlorosulfonated polyethylene (hypalon), chlorinated polyethylene or flame retardant 105 degree C or polyvinyl chloride.
3. Fire Alarm Cable shall be UL listed, made of Teflon and approved by the East Rockaway Building Department, Material and Equipment Acceptance Division.
4. Communication and Fire Alarm Cable shall be by General Cable Corporation, Belden Company with Beldfoil shielding or equal to be approved by the Engineer.

2.2 600 VOLT INSULATED WIRE AND CABLE

A. 600 volt insulated wire and cable shall be used for all 600 volt and below power, lighting, control and alarm circuits. The size and quantity of 600 volt insulated wire and cable shall be as indicated in the conduit and cable schedule. The conductor jacket shall be in accordance with color identification requirements specified under Article 3.03.

B. 600 volt single conductor wire and cable for installation in conduit shall be in accordance with the following:
1. Conductors shall be stranded, tinned coated copper, single conductor cable conforming to ASTM B8, and B33, No. 12 AWG minimum size.
2. Insulation shall be flame-retardant EPR (FREP), moisture and heat resistant thermoset rated 90 degrees C in dry locations and 90 degrees C in wet locations and listed by UL as type XHHW-2 or RHW-2.
3. XHHW-2 shall be used for all indoor circuits and RHW-2 for all underground and outdoor circuits.
4. 600 volt insulated wire and cable for installation in conduit shall be by Okonite Company, General Cable Corporation or equal to be approved by the Engineer.

C. When identified in the conduit and cable schedule 600 volt multiple conductor cable shall be used for control and alarm circuits in the quantities indicated. 600 volt multiple conductor control cable for installation in conduit shall be in accordance with the following:
   1. Conductors shall be stranded, tinned coated copper conforming to ASTM B8 and B33, No. 12 AWG minimum size.
   2. Insulation shall be moisture and flame resistant cross-linked polyethylene rated 90 degrees C in wet and dry locations and listed by UL as type XHHW-2.
   3. Cable conductors shall be assembled together with flame and moisture resistant filters and tape to make round.
   4. Cable shall include an overall protective jacket of polyethylene compound, 45 mils minimum thickness.
   5. 600 volt multiple conductor control cable shall be Okonite Company, General Cable Corporation or equal to be approved by the Engineer.

D. Security system cables shall be 600 Volt insulated. Minimum size conductors for the security system shall be No.22 AWG. Where specifically shown on the Contract Drawings or stated in the Specifications, security system shall use twisted shielded cable or coaxial type cable.

2.3 MEDIUM VOLTAGE INSULATED WIRE AND CABLE

A. Medium voltage insulated wire and cable shall be rated for an insulation level of 133 percent at the system nominal phase voltage. Cable insulation shall be thermosetting rubber based suitable for normal installation, indoors or outdoors, in conduit, in air, and intermittent or continuous submersion in water. Cable shall be single conductor bearing UL label “MV 90" and comply with or exceed ICEA S-68-516 and AEIC CS6-87.

B. The size and quantity of medium voltage insulated wire and cable shall be as indicated in the conduit and cable schedule. Medium voltage insulated wire and cable shall be in accordance with the following:
   1. Conductors shall be soft or annealed tinned coated copper with concentric-lay Class B round stranding in accordance with the current ASTM Standard B 8 and B 33.
   2. The cable insulation system shall include two separate shield layers and the primary insulation.
      a. Conductor Shield: The conductor shield shall consist of an extruded inner layer of non-conducting energy suppression or semiconducting material.

b. Primary insulation: The primary insulation shall be a high quality ozone resistant ethylene-propylene rubber based compound. The insulation system shall be suitable for use at conductor temperatures not exceeding 90 C for normal operation, 130 C for emergency overload conditions, and 250 C for short circuit conditions. Minimum average thickness of the insulation system at any point of the cable shall not be less than 115 mils for 5 kV systems, 220 mils for 15 kV systems and 345 mils for 25 kV systems. The minimum thickness at any part of the cable shall not be less than 90 percent of the specified average.

c. Insulation Shield: The insulation shield shall be an outer layer of semi-conducting material consisting of a 5 mil copper tape applied helically with a minimum 12-1/2 percent overlap.

3. Jacket: A continuous jacket of moisture, heat, oil resistant chlorosulfonated polyethylene base compound shall be applied over the insulation and shielding system. The average minimum thickness of the jacket at any point of the cable shall be in accordance with ICEA S-68-516 Table 4-3.

4. Medium voltage insulated wire and cable shall be by General Cable Corporation, Okonite Company, Kerite Company, or equal to be approved by the Engineer.

2.4 600 VOLT AND BELOW WIRE AND CABLE ACCESSORIES

A. Cable connectors shall be provided for terminating 600 volt and lower voltage wire and cable. Connectors for wire and cable up to 600 volt shall be solder less type and properly sized to fit fastening device and wire size. Connectors shall be in accordance with the following:

1. For wire sizes up to and including No. 6 AWG, compression type with UL 486A listing shall be used. All cable terminations for conductors No. 10 AWG and smaller shall be terminated using UL listed ring tongue type, nylon insulated connectors, at each terminal board.

2. For wire sizes No. 4 AWG and above, either compression type or bolted type with tin-plated contact faces shall be used.

3. For wire sizes No. 250 kcmil and larger, connectors with at least 2 cable clamping elements or compression indents and provision for at least 2 bolts for joining to apparatus terminal shall be used.

4. Compression connectors shall be Power-Connect, ring tongue shall be Series 83 as manufactured by Ideal Industries. Connectors shall also be by Thomas and Betts, Burndy or equal approved by the Engineer.

B. Cable splicing for 600 volt and below wire and cable shall be performed when terminals are not provided. Splicing shall be in accordance with the following:

1. For wire sizes No. 8 AWG and larger, splices shall be made up with compression type copper splice fittings with UL 486A listing. Splices shall be taped and covered with materials recommended by the cable manufacturers, to provide insulation equal to that on the conductors.
2. For wire sizes No. 10 AWG and smaller, splices shall be made up with pre-insulated spring connectors. Connectors shall be flame retardant with UL listing.
3. For wet locations, splices shall be submersible rated for underwater use. Underwater splices shall be rated for 10,000 psig. The splices shall be precision precast polyurethane compression dams, waterblock solder pins and an amber polyurethane overmold to prevent all water from entering the cable and keeping seawater outside the cable from passing through the splice to the electrical connection. Underwater splices shall be UL listed. All underwater splices shall be manufactured by PMI Industries or approved equal.
4. Compression splices shall be by Ideal Industries, Thomas and Betts, Burndy, or equal to be approved by the Engineer. Waterproof compression splices shall be thermo-shrink as manufactured by Ideal Industries. Waterproof compression splices shall also be by Thomas and Betts, Burndy, Buchanan or equal approved by the Engineer.
5. Spring connector splices shall be Twister type and Twister DB type for waterproof, as manufactured by Ideal Industries. Spring connectors shall also be by Thomas and Betts, Burndy, or equal approved by the Engineer.

C. Cable markers shall be provided for the identification of 600 volt and below wire and cable. Markers for 600 volt and below wire and cable shall be in accordance with the following:
1. Markers shall be vinyl type, moisture, heat and abrasion resistant with adhesive back. Cable identification shall be clearly marked.
2. Markers shall be by Ideal Industries, Thomas and Betts or equal to be approved by the Engineer.

D. Pulling compound shall be provided to facilitate wire pulling. Pulling compound shall be in accordance with the following:
1. Pulling compound shall be waxed based, with a .17 average coefficient of friction and a temperature range of 30 to 190 degrees F. The compound shall be compatible with all cable types.
2. Pulling compound shall be Ideal Industries, Greenlee or equal to be approved by the Engineer.

2.5 MEDIUM VOLTAGE WIRE AND CABLE ACCESSORIES

A. Cable connectors shall be provided for connecting medium voltage wire and cable. Connectors shall be in accordance with the following:
   1. Connectors shall be copper, tin-plated, long barrel compression type, UL listed. Suitable for voltage applications up to 35KV. Connectors shall be Power-Connect type as manufactured by Ideal or equal approved by the Engineer.
   2. For sizes 250MCM and larger connectors shall be two-hole mount type with provisions for two bolts for joining to apparatus terminal.
   3. Connectors shall be by Ideal Industries, Thomas and Betts, Burndy or equal to be approved by the Engineer.

B. Cable terminators shall be provided for terminating medium voltage wire and cable. Terminations shall be in accordance with the following:
   1. Cable terminations shall meet Class 1 requirements and be design-proof tested per IEEE 48.
   2. Terminations shall be of the molded elastomer, wet-process porcelain or heat-shrinkable types with grounding provisions for the cable shielding.
   3. Terminations shall be Elastimold, G&W Electric Company, Raychem Corporation or equal to be approved by the Engineer.

C. Cable splices shall be provided for splicing medium voltage wire and cable, splicing shall be in accordance with the following:

   For dry locations:
   1. Cable splices shall be made using standard splice kits which reinstate the cable's insulation and jacket and continue the metallic shielding through the entire cable joint.
   2. Splices shall be of the premolded splice, conventional tape or heat-shrinkable type.
   3. Splices shall be Elastimold, G&W Electric Company, Raychem Corporation or equal to be approved by the Engineer.

   For wet locations:
   1. Splices shall be submersible rated for underwater use. Underwater splices shall be rated for 10,000 psig. The splices shall be precision precast polyurethane compression dams, waterblock solder pins and an amber polyurethane overmold to prevent all water from entering the cable and keeping seawater outside the cable from passing through the splice to the electrical connection. Underwater splices shall be UL listed. All underwater splices shall be manufactured by PMI Industries or approved equal.

D. Pulling compound shall be provided to facilitate wire pulling. Pulling compound shall be in accordance with the requirements specified under Paragraph 2.4 D.

2.6 SHOP TESTS

A. Certified Shop Tests:
   1. Shop testing shall be performed on the wire and cable at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of ICEA and UL and shall demonstrate that the wire and cable tested conforms to the requirements specified.
   2. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.
   3. All low voltage wire and cable shall be shop tested in accordance with the requirements of Underwriters' Laboratories.
   4. All medium voltage wires and cables shall be shop tested in accordance with the following:
      a. Conductors shall meet the electrical resistance requirements of ICEA-S-68-516, Part 2.5.
      b. Insulation Resistance test shall be performed in accordance with the requirements of ICEA S-68-516, Part 6.28. Each cable shall have an insulation resistance not less than that corresponding to the insulation resistance constant of 20,000 megohms - 1000 ft. at 15.6 degrees C.
      c. A high voltage AC and DC test shall be performed in accordance with the requirements of ICEA S-68-516, Part 6.27. The AC and DC test voltages shall be in accordance with Section B of AEIC CS6.
      d. Shield resistance shall be measured and recorded from end to end on the completed cable.
      e. Each reel of completed shielded power cable shall be partial discharge tested in accordance with Section E and F of AEIC CS6.

B. Witnessed Shop Tests:
   1. The Contractor shall perform witnessed shop tests in accordance with the Specifications.
   2. The Engineer shall have access during working hours for inspection purposes to all parts of the works where material and cable are being manufactured, and all reasonable inspection and testing facilities shall be provided to him without increase in price. The Engineer may request that dielectric strength tests and measurements be made to verify the cable data furnished by the Contractor. For this purpose the Contractor shall furnish without increase in price, a length of cable, not to exceed 3 feet for each size to be cut from one or more reels as directed by the Engineer. Each sample shall be marked with a tag bearing full description of cable insulation and number of reel from which it is cut.

2.7 PROCESS NETWORK CABLE

A. Process network cable shall be utilized for interior data highway systems and circuits where shown on the Contract Drawings or in Section 16900, Cable and Conduit Schedule.

B. All process network cable provided under this Contract shall be furnished by a single manufacturer.

C. The process network cable shall have the following specifications:
   1. Category 6 plenum cable.
   2. 4 Pair - AWG 24 solid copper conductors.
   3. FEP insulation with PVC overall jacket.
   4. Meets ANSI/TIA/EIA-568-A performance specifications.
   5. Characteristic impedance: 100+/-15 ohms.
   6. DC resistance: 7 ohms (maximum).
   7. DC resistance unbalance: 2.5% (maximum).
   8. Mutual capacitance: 5.6 nF/100 meters (maximum).
   9. Pair-to-pair capacitance unbalance: 100 pF/100 meters (maximum).
   10. Manufactured to UL444 and flame tested to UL910.
   11. UL rated Type CMP and MMP.

D. Cable shall be equal to Southwire Cyber Technologies, “Cyber LAN Category 6 plenum.”

2.8 ARMORED METAL-CLAD CABLE

A. When identified in the cable and conduit schedule, armored metal-clad cable shall be used for all temporary power circuits. The armored metal-clad cable shall be in accordance with the following:
   1. Conductors shall be stranded, tinned, copper cable conforming to ASTM B8 and B33, No. 12 AWG minimum wire size.
   2. Insulation shall be flame-retardant EPR (FREP), moisture and heat resistant, thermoset, rated 90 degrees C in dry or wet locations and be listed by UL as Type MC-HL, Type XHHW-2 or Type RHW-2.
   3. Cable shall be assembled together with flame and moisture resistant fillers and tape.
   4. Cable shall include an impervious, continuous, welded, corrugated aluminum sheath, which shall be resistant to gases, moisture, and liquids.
   5. Cable shall include a bare stranded copper grounding conductor meeting the requirements of NFPA 70 and UL 1569.

6. XHHW-2 shall be used for all indoor circuits and RHW-2 for all underground circuits.
7. The cable shall be provided with all fittings and hardware necessary for proper installation.
8. The armored metal-clad cable shall be as manufactured by Okonite Company, BICC Cable Company or Rockbestos Cable Company.

2.9 FIBER OPTIC CABLE, FIBER OPTIC CABLE TYPES, AND PATCH PANEL

A. Fiber optic cable shall be utilized for SCADA, telephone, security, communications, CCTV and instrumentation circuits where shown on the Contract Drawings or in Section 16900, Cable and Conduit Schedule

B. Laser-Optimized 50/125 micrometer Fiber Optic Cable (OM4)
   1. The multimode fiber utilized in the optical fiber cable shall meet ANSI/TIA/EIA-568-C.3, "Optical Fiber Cabling Components Standard" and corresponds to designation OM4 (TIA 492AAAD) per ISO/IEC 11801 or ISO/IEC 24702.
   2. The fiber shall operate at wavelengths 850/1300 nm, with maximum attenuation of 3.0/1.0 dB/km at these respective wavelengths. For 1 Gb Ethernet link, performance assured to 1000/600 m at these respective wavelengths.
   3. Manufacturer:
      (1) Corning Cable Systems
      (2) Belden Cable
      (3) Black Box
      (4) Or approved equal

C. Fiber Optic Cable Types
   1. Loose Tube Fiber Optic Cable (Indoor/Outdoor)
      a) Cable shall be flame-retardant, UV stabilized, fully water blocked with dielectric central member for use in indoor/outdoor applications. The buffer tubes shall be gel-free. Each buffer tube shall contain a water-swellable yarn for water-blocking protection. Cable shall be suitable for installation in duct, aerial, and riser environments. Cable shall meet UL OFNR specifications and not require transition splicing upon building entry in order to meet fire codes.
      b) Optical fibers shall be placed inside a buffer tube.
      c) Each buffer tube shall contain 12 fibers (6-pairs).
      d) In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

e) Buffer tubes shall be kink-resistant within the specified minimum bend radius.
f) Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.
g) The central anti-buckling member shall consist of a glass-reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.
h) The cable core shall contain a water-blocking material. The water-blocking material shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional non-toxic solvents. Cable shall contain water-blocking threads between tubes.
i) The cable shall contain at least one ripcord under the sheath for easy sheath removal.
j) Tensile strength shall be provided by a combination of high tensile strength dielectric yarns.
k) The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.
l) All dielectric cables (with no armoring) shall be sheathed with medium density polyethylene (MDPE). The minimum normal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water-blocking material. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

D. Fiber Optic Patch Cables
1. Fiber optic patch cable shall be two-fiber zipcord 50/125 core/clad micron multimode riser rated cable.
2. Installation of patch cables shall include all spares and observe the minimum fiber bend radius and strain relief.
3. Manufacturer:
(1) Corning Cable Systems
(2) Belden Cable
(3) Black Box
(4) Or approved equal

E. Fiber Optic Patch Panels:
1. Wall mounted fiber optic patch panels meeting the following minimum specifications
a. Capacity for 48 connectors and jumpers.

b. Thin modular low profile splice tray shall accommodate splicing for fusion and mechanical splices.
c. Dual doors shall be provided to separate the cable entry section and the patch panel side.
d. Provide cable routing from the top and bottom of both panel sections.
e. Enclosures shall be manufactured from 16-gauge, cold rolled steel.
f. Panels shall be provided with grounding and strain relief lugs to support the fiber cable.
g. Provide cable tie-down support islands to take up excess fiber optic cable and insure it does not exceed its maximum bending radius.
h. Provide cable bulkhead adapters pre-mounted on eight plates, six connectors per plate (dual fiber connectors count as two).
i. Panels shall be inspected to assure that there are no sharp edges which could damage the fiber optic cable.
j. Patch panel dimensions shall be a minimum of 13.5" high x 22.5" wide x 4" deep.
k. Patch panel shall be mounted in a painted steel NEMA 12 enclosure.
l. Manufacturer: Patch panels shall be as manufactured by:
   (1) Net Optics
   (2) Siecor
   (3) Or approved equal

PART 3 - EXECUTION

3.1 GENERAL

A. All cables and wires shall be installed within the raceways as shown on the Contract Drawings. They shall be carefully handled so as to avoid twists or kinks in the conductors or damage to the insulation.

B. The Contractor shall ensure that the manufacturer's recommended cable bending radii and pulling are not exceeded and that the number of conductors permitted in a conduit are in accordance with the latest applicable section of NFPA 70 National Electrical Code.

C. No splices shall be permitted between terminals except at approved junction or terminal boxes. Boxes shall be provided as shown on the Contract Drawings or as required by Code for the pull lengths. No more than two terminations shall be made at each terminal point. Cable and wire runs shall be looped through pull boxes without cutting and splicing where possible. All splices below grade, in manholes, hand holes and wet locations shall be water proofed.

D. No splicing of instrument wiring shall be permitted. Instrument wiring shall be extended by use of field termination boxes employing labeled terminal strips. Shield continuity shall be maintained. Ultimate shield termination (ground) shall be at one end only.

E. The mineral-insulated metal sheath cable manufacturer's representative shall review the cable installation to certify that the cables are installed in accordance with the manufacturer's requirements.

3.2 INSTALLATION OF WIRING

A. Cables shall be installed complete with proper terminations at both ends. For each motor circuit, Contractor shall ensure proper phase sequence and motor rotation.

B. Wire and cable contained within a single conduit shall be pulled simultaneously using insulating pulling compounds containing no mineral oil.

C. Pulling tension on medium voltage cables shall be continuously monitored using a calibrated Dynamometer type device, having a calibration label within six months of its use.

D. Cables shall be installed with maximum slack at all terminal points, boxes, handholes and manholes.

E. Medium voltage cables located within manholes, handholes and boxes shall be wrapped with fireproofing tape for their entire length on an individual cable basis. Tape shall be 30 mills thick of self-extinguishing material which will not support combustion. Tape shall not deteriorate when subjected to water, salt, sewage or fungus and shall be secured with glass cloth tape. Medium voltage cables shall be fireproofed in accordance with the cable manufacturer's recommendations and then covered with tape extending at least one inch into any duct.

3.3 CONDUCTOR IDENTIFICATION

A. Each wire shall be labeled at each termination points and all splice locations. Carry individual conductor or circuit identification throughout, with circuit numbers or other identification stamped on terminal boards when provided or the cable so it is visible around the cable's circumference.

B. Each wire shall be identified in junction boxes, cabinets, and terminal boxes. Where no termination is made, use a plastic-coated, self-adhesive, wire marker.

Where termination is made, use a plastic, pre-printed sleeve wire marker. Paper, self-adhesive wire markers shall not be used.

C. In manholes and handholes, each power wire shall be identified by a laminated plastic tag located so that it can be seen from center of manhole without moving adjoining wires. Bundle and mark control wires as listed in conduit and cable schedule.

D. Multi-conductor control cables shall be color coded in accordance with ICEA S-61-402, Method 1, Table K.

E. The following identification scheme shall be used for all 600 volt and below power circuits:

System Voltage	Neutral	Phase A	Phase B	Phase C	Ground
208/120V	White	Black	Red	Light Blue	Green
240/120V	White-Gray Strip	Black-Blue Strip	Red-Blue Strip	None	Green
480/277V	Gray	Brown	Orange	Yellow	Green

F. Medium voltage cables greater than 2000 volts shall be color coded by a bright yellow colored tape band. Conductor identification shall be marked by a single wrap for Phase A, a double band for Phase B and three bands for Phase C.

3.4 600 VOLT AND BELOW WIRE AND CABLE FIELD TESTING

A. After installation, all 600 volt and below wire and cable shall be field tested. The field tests shall be performed by the Contractor who shall furnish all testing equipment. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide a report identifying the tests performed and the results obtained.

B. Each electrical circuit shall be tested after permanent cables are in place to demonstrate that the circuit and equipment are connected properly and will perform satisfactorily and that they are free from improper grounds and short circuits. The tests shall consist of the following:

1. 600 volt wire and cable mechanical connections shall be individually tested after installation and before they are put in service with a calibrated torque wrench. Values shall be in accordance with manufacturer's recommendations.

2. 600 volt and below wire and cables shall be individually tested for insulation resistance between phase and from each phase to ground. Test after cables are installed and before they are put in service with a Megger for one minute at a voltage rating recommended by the cable manufacturer or in accordance with NEMA and ICEA standards.
3. The insulation resistance for any given conductor shall not be less than the value recommended by the cable manufacturer or in accordance with NEMA and ICEA standards. Any cable not meeting the recommended value or which fails when tested under full load conditions shall be replaced with a new cable for the full length.
4. Shielded instrumentation cable shields shall be tested with an ohmmeter for continuity along the full length of the cable and for shield continuity to ground.
5. Connect Shielded instrumentation cables shall be connected to a calibrated 4-20 milliamp DC signal transmitter and receiver. Test at 4, 12, and 20 milliamp transmitter settings.

3.5 MEDIUM VOLTAGE WIRE AND CABLE FIELD TESTING

A. The Contractor shall provide acceptance testing of the medium voltage wire and cable. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

B. Each medium voltage wire and cable circuit shall be acceptance tested on an individual per phase basis, all testing and inspection shall be performed by the testing firm.

C. Visual and mechanical inspection shall be performed for all splices and terminations.

D. Electrical tests shall be performed for each power cable. Testing shall include the shield continuity test and the DC high potential test and shall be in accordance with the following:
   1. The following procedures shall be adhered to before performing dc over potential tests:
      a. All equipment transformers, switches, motors, circuit breakers, surge arrestors, etc. shall be disconnected from cable circuit to prevent test interruptions due to flashovers or trip outs resulting from excessive leakage current.
      b. Adequate clearance shall be established between the circuit test ends and any grounded object and to other equipment not under test.
      c. Circuit conductors not under test shall be grounded including all cables shields and nearby equipment.
      d. Insulation surfaces shall be cleaned.

e. Cable ends shall be keep dry.

2. High-potential shall be applied slowly in 8 to 10 equal steps to 80 percent of the NETA test value or manufacturer's shop production test value, whichever is smaller. Record the leakage current at each test voltage and plot the curve on graph paper.
3. The test shall be stopped, if the leakage current increases excessively or a "knee" appears in the curve before reaching maximum test voltage.
4. Upon reaching the specified maximum test voltage, the voltage shall be maintained for 15 minutes, record the leakage current at 30 seconds and one minute and at one-minute intervals thereafter. Plot leakage current versus time on the same graph as the step voltage curve.
5. Conductor test potential shall be reduced to zero and measure residual voltage at discrete intervals.
6. Grounds shall be applied to drain all insulation stored charge. Conductors shall be connected to ground through a suitable discharge resistor for one minute and then subsequently grounded directly.
7. New cable failing the test shall be replaced and retested.
8. The test curves shall be signed by the tester and initialed by the Engineer.

E. All tests and values for wire and cable shall be in accordance with the manufacturer's recommendations and NETA, ATS Acceptance Testing Specification.

F. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA, ATS Acceptance Testing Specification.

3.6 FIBER OPTIC CABLE FIELD TESTING

A. General

1. Install all fiber optic cable in accordance with the manufacturer's recommendations.
2. Provide pull boxes as needed to safely pull cable without damage.
3. Terminate both ends of all cables in a separate fiber optic patch panel, unless otherwise shown in a common patch panel.
4. Provide fiber optic jumper cables to interconnect between patch panels.
5. Provide support for all riser cables to reduce tensile load below eighty percent of the manufacturer's maximum long term tensile load requirements.
6. Inspect all fiber optic cables before and after installation.
7. Faulty fiber optic cables shall be removed and replaced at no additional cost to the County.
8. Provide long radius elbows which are in excess of the manufacturer's advertised long-term minimum bending radius.

9. Where two cables join, provide two patch panels mounted adjacent to each other with necessary jumpers between panels provided.
10. Terminate all fibers in every cable with extras tagged as spare.

B. Provide the services of the fiber optic cable manufacturer to inspect the installation of each cable. Test each fiber between its patch panel bulkhead connectors for optical power loss and frequency response. All fibers shall be verified to meet manufacturer's advertised specifications.

+ + END OF SECTION + +

SECTION 16131

ELECTRICAL CONDUIT SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing conduit system. The conduit system shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The conduit system required shall be provided with all rigid and flexible conduits, boxes, fittings, supports, hangers and inserts and other conduit accessories as required for the installation of the electric wire and cable.

C. The conduit system proposed for all instrumentation circuits shall be approved by the Contractor before Engineer approval can be given. The circuits shall include all equipment and devices specified in Division 15 and their associated conduit runs.

D. The conduit system proposed for all the HVAC instrumentation circuits shall be approved by the Contractor before Engineer approval can be given. The circuits shall include all instrumentation equipment and devices specified in Division 15, such as transmitters, analyzers, monitors, PLC's, CPU's, workstations, etc. Fans, air conditioners, heaters and other mechanical equipment circuits will not require the above approvals.

E. All PVC coated conduit installed shall be the same uniform gray color. No other color variations will be accepted. All RGS conduit shall be painted to match the same uniform gray color of the PVC coated conduit delivered to the site.

F. Every conduit shall be tagged to define its system served: power, process/mechanical, instrumentation, telephone, fire alarm, communications and lighting.

G. Where conduit enters and exits pull boxes, junction boxes, terminal boxes, etc. the labels for conduit tags shall be placed on the interior of the box on the conduit bushings.

1.2 RELATED SPECIFICATIONS

A. Specification 05050 - Metal Fastening.

B. Specification 09900 - Painting.

C. Specification 16071 – Supporting Devices.

1.3 PAYMENT

A. Payment for Electric Conduit System shall be made as provided in Division 1 of the Specifications.

1.4 REFERENCES

A. Electric conduit system shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. IEEE 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems.
   3. UL Standard No. 6, Rigid Metal Electrical Conduit.
   4. UL Standard No. 50, Electrical Cabinets and Boxes.
   5. UL Standard No. 360, Liquid-Tight Flexible Steel Conduit.
   6. UL Standard No. 514A, Metallic Outlet Boxes.
   7. UL Standard No. 514B, Fittings for Conduit and Outlet Boxes.
   8. UL Standard No. 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.
   9. ANSI C80.1, Specification for Zinc Coated Rigid Steel Conduit.
   10. ANSI C80.4, Specification for Fittings for Rigid Metal Conduit and Electrical Metallic Tubing.
   11. NEMA Standard No. RN-1, PVC Externally Coated Galvanized Rigid Steel Conduit.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Prior to equipment submission, submit a list of proposed manufacturers with the products they produce proposed for the contract.
   2. Manufacturer's catalog cuts for the conduit, boxes, fittings and supports proposed for use.
   3. Construction details of conduit racks and other conduit support systems with seismic restraint details and calculations signed by a licensed Engineer.
   4. Scaled working drawings showing proposed routing of all conduits, inclusive of conduits embedded in structural concrete and conduits directly buried in

earth. Drawings shall show locations of pull and junction boxes and all penetrations in walls and floor slabs.

C. Field test report shall be submitted.

D. Contractor is responsible for retaining a New York State Registered engineer to design the hanger systems to support the electrical raceways. Contractor shall submit a signed and sealed shop drawing along with calculations for review and approval by the engineer of record.

1.6 DELIVERY, STORAGE AND HANDLING

A. Electric conduit system shall be delivered, stored and handled in accordance with the Specifications, the manufacturer's instructions and the following:
   1. Conduit shall be delivered to the work in standard bundles having each length suitably marked with the manufacturer's name or trademark and bearing the label of the Underwriters' Laboratories, Incorporated, inspection service.

PART 2 - PRODUCTS

2.1 RIGID STEEL CONDUIT

A. The Contractor shall provide rigid steel conduit. All steel conduit shall comply with the requirements of ANSI C80.1, and the Underwriters' Laboratories, Incorporated, Standard for No. 6.

B. Both the inside and outside surfaces of the rigid steel conduit shall be protected against corrosion by a coating of zinc applied by the hot-dip galvanizing process.

C. Conduits, elbows and couplings shall be rigid, heavy wall, mild steel, hot dip galvanized. Conduits, elbows and couplings shall have a smooth interior with tapered threads and carefully reamed ends. Conduit size shall be 3/4-inch minimum and shall conform to UL-6.

D. Conduits, elbows and couplings shall include a PVC coating for all areas. For conduits located indoors in dry, dusty areas the use of rigid steel conduit without PVC coating shall be permitted.

E. PVC coated conduit shall be factory applied and shall include a smooth 2 mil thick urethane interior coating and 40 mil thick polyvinyl chloride exterior coating. The exterior PVC coating color shall be gray. The threads of conduits that have been cut to size shall have the same PVC coating applied in the field. PVC coated conduit shall conform to NEMA Standard RN-1.

F. Rigid steel conduit shall be by Allied Tube and Conduit Corporation, Wheatland Tube Company or approved equal. PVC coated rigid steel conduit shall be by Perma-Cote Industries, OCAL Incorporated, Robroy Industries or equal to be approved by the Engineer.

2.2 HANGERS, SUPPORTS AND INSERTS

A. The Contractor shall provide hangers, supports and inserts for support of the electric conduit system. The supports shall securely attach the electric conduit system to the channel and structure.

B. The electric conduit system shall be designed, constructed and installed suitable for earthquake regulations in accordance with the seismic requirements of the Nassau County Building Code and the Uniform Building Code for Zone 2A application.

C. Transverse and longitudinal bracing shall be provided as required to brace the electric conduit for the seismic requirements specified.

D. All drilled in type concrete inserts shall be expansion shields or anchors conforming to Specification 05092 - Metal Fastening and 15060 - Hangers and Supports. In corrosive locations, concrete inserts shall be 316 stainless steel.

E. Hangers and supports shall be in accordance with the requirements of Specification 15060 - Hangers and Supports except beam clamps, hanger rods and hardware shall be steel with electro-plated zinc finish. This shall also include bolts, nuts and washers. In corrosive locations, hangers and support hardware shall be type 316 stainless steel or factory applied 40 mil thick PVC coated.

F. Hangers, Supports and Inserts shall be by B-Line, Kindorf or equal to be approved by the Engineer.

2.3 FLEXIBLE METALLIC CONDUIT

A. The Contractor shall provide flexible metallic conduit where required to permit movement of connected devices and where it is impracticable to complete runs with rigid conduit.

B. Liquid-tight flexible metallic conduit shall be used for all indoor non-hazardous areas.

C. Liquid-tight flexible metallic conduit shall be used for all outdoor non-hazardous areas.

D. For hazardous areas flexible conduit shall include a brass inner core with a bronze outer braid and protective neoprene plastic coating. End fittings shall be steel, brass or bronze.

E. Flexible conduit shall be by Anaconda American Brass Company, Electric-Flex Company or approved equal. Hazardous area flexible conduit shall be by Crouse Hinds Company, Appleton Electric Company or equal to be approved by the Engineer.

2.4 OUTLET BOXES AND FITTINGS

A. The Contractor shall provide outlet boxes and fittings for rigid and flexible conduit. The outlet boxes and fittings required for the work which constitutes a part of the conduit system, shall be of approved types.

B. For outdoor, wet and corrosive areas, conduit fittings and outlet bodies shall be cast gray iron alloy, cast malleable iron bodies and covers. All units shall be gasketed, watertight, and threaded with five full threads and shall have rust-proofing in accordance with the requirements of Article 2.6. Fittings and bodies installed on PVC coated conduits shall also include interior and exterior coatings equivalent to the conduit.

C. Threaded cast ferrous metal, hub type outlet boxes shall be used throughout, except in the interior walls of superstructures and in roof slabs protected by built-up roofing where pressed steel boxes shall be installed. Cast iron or alloy outlet boxes of the proper size and depths for the application, complete with watertight gaskets and covers secured by brass screws, shall be furnished and installed as indicated on the Contract Drawings or as required by the conduit run. Outlet boxes, furnished and installed for the installation of lighting fixtures, switches and receptacles in a future contract, shall be furnished with watertight gaskets and blank covers.

D. For non-hazardous, indoor dry dusty areas pressed steel boxes of the proper size and depths for the application shall be provided. Boxes shall be rated NEMA 12, not less than No. 14 U.S. Standard Gauge (0.078 inch). The conduit openings shall be provided with oil-resistant gaskets. Conduits shall be fastened to these boxes with locknuts and bushings, and all unused outlets or holes shall be left sealed.

E. All outlet boxes intended for fixtures shall be provided with approved fixture studs.

F. For concealed conduit runs in outside walls and all exposed conduit work, connections to boxes and fittings shall be made through threaded holes, unless otherwise approved by the Engineer. For concealed conduit work in non-hazardous areas in other than outside walls, connections between conduit and boxes may be made with drilled holes, using locknuts and bushings. Where necessary unions may be used. Unions in hazardous locations shall be Crouse Hinds type UNF, UNL, UNY conduit fittings or equal to be approved by the Engineer. Unions in non-hazardous areas shall be Universal or Erickson conduit couplings or equal to be approved by the Engineer.

G. All boxes installed for concealed conduit, shall be provided with extension rings or plaster rings and covers as required. For non-hazardous, dry indoor areas stainless 302/304, satin beveled steel cover and device plates for surface mounted boxes shall be used. For corrosive locations, galvanized ferrous and galvanized cast ferrous metal cover and device plates with neoprene gaskets shall be used.

H. Outlet boxes and fittings installed on PVC coated conduit shall also include interior and exterior coatings equivalent to the conduit.

I. For receptacle, switch, fixture, and other device outlet boxes recessed in walls, or exposed within hung ceiling spaces, in non-hazardous, indoor, dry areas above grade, standard galvanized pressed steel outlet boxes with partially pre-punched conduit connection cutouts, of the proper size and depth for the application, shall be provided. Conduits shall be fastened to these boxes with locknuts and bushings. Similar pressed steel boxes with blank covers may be used for junction and pull boxes in conduit runs where pressed steel device boxes are permitted.

2.5 CONDUIT ACCESSORIES

A. The Contractor shall provide conduit accessories for use with the conduit system. The conduit accessories shall be of approved types.

B. Expansion and Deflection Fittings:
   1. Expansion and deflection fittings shall be made up of non-corrodible parts and shall provide for ample longitudinal and lateral movement. A suitable bond shall provide a low resistance, continuous longitudinal path for ground currents.
   2. Expansion and deflection fittings shall be watertight cast iron, malleable iron or hot dipped galvanized. Fittings shall be corrosion-resistant, UL listed and compatible with the conduit system.
   3. Expansion /deflection fittings shall provide both expansion and deflection in a single fitting in accordance with the following:
      a. Axial expansion or contraction up to 3/4-inch.
      b. Angular misalignment up to 30 degrees.

c. Parallel misalignment up to 3/4-inch.

4. Expansion fittings shall provide expansion /contraction with eight inch total movement.
5. Expansion and deflection fittings shall be by Crouse Hinds, Appleton Electric or equal to be approved by the Engineer.

C. Sealing Fittings:
   1. Sealing fittings shall be cast gray iron alloy or cast malleable iron or copper free aluminum with zinc electroplate and lacquer or enamel finish.
   2. Sealing fittings shall have an ample opening with threaded closure for access to conduit hub for making dam. Sealing fiber and compound shall be suitable for use with the fitting and shall be the products of the fitting manufacturer.
   3. For corrosive locations, seal fittings shall include interior and exterior coatings equivalent to the PVC conduit coating specified under Article 2.01.
   4. Sealing fittings shall be by Crouse Hinds, Appleton Electric or equal to be approved by the Engineer.

D. Drain Fittings:
   1. Drain fittings shall be a combination device designed to provide ventilation to minimize condensation and drains accumulated condensate.
   2. The combination drain/breather fitting shall be 3/8 inch male thread size with stainless steel body.
   3. Drain fittings shall be by Crouse Hinds, Appleton Electric or equal to be approved by the Engineer.

E. Conduit Hubs:
   1. Conduit hubs shall be threaded, insulated throat type with bonding screw locknut.
   2. The conduit hub and locknut shall be malleable iron or zinc and shall include a 90 degree C insulating surface and a sealing ring for a water tight and dust tight connection.
   3. Conduit hubs shall be by 0-Z Gedney, Thomas and Betts or equal to be approved by Engineer.

F. Conduit Bushings:
   1. Conduit bushings shall be insulated, grounding type with lay-in-lug connection. Two locknuts shall be provided for each bushing.
   2. The conduit bushing and locknuts shall be steel, malleable iron or zinc. The bushing shall include a 90 degree C insulating surface.
   3. Conduit bushings and locknuts shall be by 0-Z Gedney, Thomas and Betts or equal to be approved by the Engineer.

G. Duct Seal:

1. Duct seal shall be a soft, fibrous non-hardening sealing compound for sealing between cables and conduits.
2. Duct seal shall be by O-Z Gedney, Ideal Industries or equal to be approved by the Engineer.

H. Thruwall Seals and Bushings:
   1. Thruwall seals and bushings shall be in accordance with the following:
      a. For conduits and cables in new construction and passing through exterior subsurface walls and exterior concrete walls, thruwall seals shall be used. Thruwall seals shall be Type WSK and WSCS manufactured by O-Z/Gedney or equal to be approved by the Engineer.
      b. For conduits and cables in new construction and passing through concrete floors and floor slabs, floor seals shall be used. Floor seals shall be type SK and FSCS manufactured by O-Z/Gedney or equal to be approved by the Engineer.
      c. For conduits passing through exterior block walls or installed in existing construction passing through exterior subsurface walls, exterior concrete walls, floor slabs and roof slabs for use in core bit-drilled holes sealing bushings shall be used. Sealing bushings shall be Type CSMI at the inside of the structure and Type CSMC at the outside of the structure, within the same core drilled hole. Sealing bushings shall be manufactured by O-Z/Gedney or equal to be approved by the Engineer.
      d. For conduits passing through existing interior concrete walls or floors and interior block walls sealing bushings shall also be used. Sealing bushings shall be CSMC or CSMI type as manufactured by O-Z/Gedney or equal to be approved by the Engineer.
      e. For conduits passing through fire rated floors and walls fire stop fittings shall be used. Fire stop fittings shall be CFS and/or CFSI type as manufactured by O-Z/ Gedney or equal to be approved by the Engineer.
      f. For multiple conduit runs passing through interior or exterior and fire rated walls thru- wall barriers shall be used. Thru- wall barriers shall be TW series by Crouse-Hinds or equal to be approved by the Engineer.

I. Conduit Tags:
   1. Conduit tags shall be Setmark snap around conduit markers which shall be secured to the conduit with annealed brass wire.
   2. Conduit tags shall be clearly stamped with the conduit number in conformity with the conduit and cable schedule or as directed by the Engineer.
   3. Conduit tags shall be by Seton Nameplate Corporation or equal to be approved by the Engineer.

J. Conduit Markers:

1. Conduit identification markers shall be self-sticking color-coded tape. Identification tape shall be two inches wide and colored in accordance with the color banding specified under this section.
2. Conduit markers shall be by Thomas and Betts or equal to be approved by the Engineer.

2.6 TERMINAL, JUNCTION AND PULL BOXES

A. The Contractor shall provide terminal, junction and pull boxes as shown on the Contract Drawings and where otherwise required, or as directed by the Engineer.

B. Boxes located indoor in dry, dusty areas shall be NEMA Type 12, constructed of welded and galvanized sheet steel. Boxes 24 inches and less shall be 14 USS standard gauge metal. 12 USS standard gauge metal on boxes greater than 24 inches, except 10 USS standard gauge shall be used for boxes with any dimension of 36 inches or more.

C. Boxes located in other areas shall conform to the following area classifications:
   1. For wet locations boxes shall be watertight NEMA Type 4. Boxes shall be constructed of galvanized cast iron and shall include gasketed, bolt on covers, with tapped holes in bosses or hubs for conduit entrance. Boxes shall be provided with cast mounting lugs for installation in concrete.
   2. For hazardous locations boxes shall be explosion proof NEMA Type 7. Boxes shall be constructed of cast iron and shall include threaded connections and ground joint surfaces.
   3. For corrosive locations boxes shall be corrosion resistant, NEMA Type 4X. Boxes shall be constructed of 316 stainless steel material with sealed seams.

D. Pull and junction boxes shall be provided with covers held in place by brass screws. Terminal boxes shall be provided with terminal block supports and approved hinged covers fitted tightly against a gasket and secured by lug bolts and wing nuts. Hinges, lug bolts, wing nuts and other fittings shall be made of an approved, non-ferrous, non-corrodible metal. All boxes shall be provided with rabbeted gaskets or flange gaskets securely held in place.

E. Tapping for threaded connections to outlet boxes, junction boxes, pull boxes and conduit fittings in non-explosion proof construction shall conform to the following:
   1. All threads shall be tapered.
   2. If threads for connection of conduit are tapped all the way through a hole in an enclosure, or if an equivalent construction is employed, there shall be not less than 3-1/2 threads in the metal and the construction of the enclosure shall be such that a suitable conduit bushing can be properly attached.

3. If threads for connections of conduit are not all the way through a hole in a boxwall, conduit hub or the like, there shall be not less than five full threads in the metal and there shall be a smooth, well rounded inlet hole for the conductors, which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing and which shall have an internal diameter approximately the same as that of the corresponding trade size of rigid conduit. The threaded hole shall be provided with a conduit end stop.
4. Tapping for threaded connections for explosion proof construction shall conform to the requirements of the National Electrical Code for construction in Class I, Division 1, hazardous locations.

F. Cast iron or cast ferrous alloy outlet boxes, junction boxes, pull boxes, conduit fittings and conduit accessories such as box covers shall be rust-proofed by zinc coating applied by the "hot-dip" process or shall be given a rust protective coating applied by either of the following methods:
1. Method A:
   a. Castings shall be given a mechanical and chemical cleaning.
   b. Castings shall be given a phosphoric acid type dip.
   c. Then a coating of zinc chromate primer shall be applied, and finally
   d. A coating of baked enamel finish shall be applied over the outside and inside surfaces of the castings.
2. Method B:
   a. Castings shall be given a mechanical and chemical cleaning.
   b. Then a coating of cadmium shall be deposited electrolytic ally.
   c. Then a coating of zinc shall be applied by electroplating.
   d. Then a vinyl resin base aluminum lacquer shall be applied.

G. Stamped steel outlet boxes, junction boxes and box covers shall be rust-proofed by a zinc coating applied by an electro-galvanizing or sherardizing process. Fabricated sheet steel boxes shall be formed from galvanized sheet steel. Welded joints shall be touched up with aluminum lacquer and boxes and covers shall be given a shop priming coat of zinc chromate rust inhibiting paint.

H. Terminal blocks shall be used within terminal boxes for termination of prepared conductors No. 10 AWG and smaller. Terminal blocks shall be in accordance with the following:
1. Terminal blocks shall be high density, screw terminal type suitable for rail mounting with quantities sufficient for the conductors to be terminated plus 20 percent spare.
2. Terminal blocks shall be NEMA rated, 600 volt, 35 ampere suitable for 85 degrees C.
3. Terminal block components shall have stainless steel and tin plated copper alloy components, backed out captive screws and marking surface.

4. Terminal blocks shall be Allen-Bradley Company, General Electric Company or equal to be approved by the Engineer.

PART 3 - EXECUTION

3.1 GENERAL

A. All conduits shall be installed in accordance with the requirements specified under this section and in conformity with the sizes stated in the Specifications or shown on the Contract Drawings. They shall be installed complete with all accessories, fittings and boxes, in an approved and workmanlike manner so as to provide proper raceways for electrical conductors.

B. The Contractor's attention is called to the fact that all conduit runs indicated on the Contract Drawings are shown diagrammatically for the purpose of outlining the general method of routing the conduits to avoid interference. Where conduit runs are not shown, it shall be the responsibility of the Contractor to establish the runs required based upon the various systems shown on the Contract Drawings.

C. Should any structural difficulties prevent the setting of cabinets, boxes, conduits, etc., at points shown on the plans, deviations therefrom as determined by the Engineer will be permitted and shall be made without additional cost.

D. All exposed steel conduits, fittings, boxes, straps, racks and hangers shall be painted in conformity with Specifications 09900 - Painting. PVC coated conduit systems shall not be painted. Paint shall match the gray color of the PVC coated conduits.

E. Conduits shall be tagged using conduit tags. Conduit tags shall be installed where conduits terminate in equipment and enclosures.

F. Exposed conduits shall be color banded using conduit markers. Markers shall also include operating voltage when over 600 volts. Conduit markers shall be installed 360 degrees, double wrap around conduit exterior. Conduit markers shall be installed where conduits enter equipment, boxes, within each room, at wall penetrations and 50 feet on centers in each area. When exposed conduits are to be painted, markers shall be installed after the conduits are painted. Color banding shall be in accordance with the following:
   1. 120/208 volt AC: Gray.
   2. 277/480 volt or 480 volt AC: Sand.
   3. 2400 volt or 4160 volt AC: Silver.
   4. 13800 volt AC: Brown.
   5. Fire Detection and Alarm: Red.

6. Telephone: Blue.
7. Intercommunication: Yellow.
8. Security System: Rust.
9. Low Voltage Switching, Instrumentation and Controls System: Black.

3.2 INSTALLATION OF RACEWAYS

A. The Contractor shall install all exposed raceways parallel or at right angles to walls and ceiling beams. Changes in directions shall be made with bends, elbows and pull boxes. All parallel runs shall be spaced uniformly throughout and secured in place with hangers and fasteners. Brace raceways to satisfy the specified seismic requirements in accordance with the restraint details.

B. Conduits, where exposed, shall in all cases be substantially supported in an approved manner, but they shall not be fastened to or come in contact with any other pipes, ducts or other work of a similar nature. In all exposed work, approved channel or angle iron hangers, racks, one-hole straps or a combination thereof shall be provided to support the conduits. Where conduits are supported with one-hole straps, spacers shall be used to provide 1/4-inch minimum clearance between the conduits and walls or ceilings.

C. Hanger rods for trapeze type hangers shall not be less than 5/8 inch diameter. Conduit supports shall be located at intervals not exceeding 8 feet. Conduits shall be securely fastened to each support with U-bolts, straps or clamps. All hanger types (trapeze and others) shall be furnished and installed in accordance with Specification 15060, Hangers and Supports. All items that are hung and supported shall be submitted as a separate shop drawing complete with licensed structural engineer P.E. seal.

D. All concealed conduits shall be placed in walls, floors, ceilings or slabs at the proper time in accordance with the progress of the structural work. The Contractor shall cooperate in every respect in meeting schedules and shall not delay the structural work unnecessarily.

E. Conduits embedded in concrete shall be blocked and braced in place by use of adequate conduit separators to prevent displacement during the pouring of concrete. The Contractor will be held responsible for proper position of conduits and shall rearrange any conduit that may be displaced while concrete is poured, without additional cost.

F. Where conduit runs are to be concealed and the Contractor fails to place such conduit in sufficient time to be included in the structures and the structures are

completed without such conduit, the Contractor shall install such runs either concealed or exposed as directed by the Engineer, with no extra payment for additional work or for more conduit than the original lengths.

G. Embedded conduit shall be run in structural concrete in the center of slabs and walls and above waterstops. Conduit connections shall be made watertight. Contractor shall confirm that concrete thickness is sufficient for embedding the quantity of conduits intended. Unless specifically shown otherwise on the Contract Drawings or stated in the Specifications, embedded conduits shall be in accordance with the following criteria:
   1. Minimum concrete thickness shall be as follows:
      a. For concrete 16 inches thick and less, the minimum concrete thickness shall be 11.5 inches plus the depth of the largest conduit assembly. The conduit assembly depth shall be from the top of the uppermost conduit to the bottom of the lowest conduit.
      b. For concrete greater than 16 inches thick, the minimum concrete thickness shall be 13.5 inches plus the depth of the largest conduit assembly.
      c. For concrete at foundation slabs, an additional inch shall be added to the minimum concrete thicknesses previously stated.
   2. Conduit spacing shall be as follows:
      a. Conduits shall be separated three times outer diameter of larger conduit center to center.
      b. For multiple conduit layer assemblies, conduits shall be separated vertically three times outer diameter of larger conduit center to center.
      c. When conduits cross at a given point, the conduits may be in direct contact and the angle of cross shall be 45 degrees or greater. Conduits may also cross within the vertical spacing of a multi-conduit layer assembly.
      d. When conduits cross a structural expansion joint, conduits shall be separated three times outer diameter of larger conduit fitting center to center.

H. A run of conduit between outlet and outlet, between fitting and fitting or between outlet and fitting shall not contain more than the equivalent of three quarter bends, including those bends located immediately at the outlet or fitting. The equivalent number of 90° bends in a single conduit run are limited to the following:

1.	Runs in excess of 300 feet	0
2.	Runs of 300 feet to 201 feet	1
3.	Runs of 200 feet to 101 feet	2
4.	Runs of 100 feet and less	3

Factory bent elbows or field bent elbows with approved tools may be used. Heating of conduit to facilitate bending is prohibited.

I. Factory-made conduit bends or elbows shall be used wherever possible in making necessary changes in direction. Field bends shall be carefully made so as to prevent conduit damage or reduction in the internal areas. The radius shall not be less than six times the nominal diameters for the conduit with carefully matched bends on parallel runs so as to present a neat appearance.

J. All conduits, where cut, shall be carefully reamed to remove burrs. No running threads will be permitted. All screw joints shall be watertight. Conduits shall be fitted in an approved manner to all devices and boxes. The ends of all conduits shall be equipped with suitable approved conduit fittings. The ends of all empty conduits shall stub up six inches above the slab and shall be capped.

K. All conduits shall be carefully cleaned before and after installation and all inside surfaces shall be free from all imperfections likely to injure the cable. Conduits shall be cleaned in accordance with the following:
   1. After erection of complete conduit runs, conduits shall be snaked with a suitable swap to which shall be attached an approved tube cleaner equipped with an approved cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit.
   2. All conduits through which the mandrel will not pass shall be removed and replaced by the Contractor at his own expense. After snaking, the ends of the dead-ended conduits shall be protected with standard malleable iron caps to prevent the entrance of water or other foreign matter.
   3. Conduit ends shall be protected after cleaning with caps to prevent entrance of water, concrete, debris or other foreign substance.

L. As far as practicable, conduits shall be pitched to drain to outlet boxes or otherwise so installed as to avoid trapping moisture. Trapped conduits in concealed construction shall be provided with outlet boxes for drainage. Where necessary drainage in outlet boxes or where dips are unavoidable in exposed conduits, a drain fitting shall be installed at the low point.

M. Thruwall type seals and conduit sealing bushings shall be installed for all conduits passing through concrete slabs, floors, walls or block walls.

N. Conduit runs shall be installed so as to avoid flues, heat sources, steam or hot water pipes. A minimum separation of 12 inches shall be maintained where conduit crosses or parallels hot water, steam pipes or heat sources.

O. Where conduit enter or leave equipment located within electrical and control rooms the conduit shall be sealed and packed with duct seal compound.

P. A 250 pound tested polyethylene pull tape shall be provided in all empty conduits, with a minimum 8 inch of slack, double backed into the conduit. Conduit shall be protected immediately after installation by installing flat non-corrosive metallic discs and steel bushings designed for this purpose at each end. Discs shall not be removed until it is necessary to clean the conduit.

Q. All conduit that is cut on the job shall be cut square and taper reamed to remove burrs before installation. Where steel conduit is cut and threaded on the site, it shall be coated before and after making connections.

R. Conduits embedded in concrete shall stub up 6 inches above the slab. A three inch high curb extending three inches from the outer surface of the conduit penetrating the floor shall be provided to prevent corrosion. Conduit stub-ups shall be terminated in couplings, slightly above the finished concrete curb.

3.3 CONDUIT CONNECTIONS TO EQUIPMENT

A. At each motor, limit switch, solenoid valve, electrical control device or other electrically controlled or operated equipment, the Contractor shall install a complete conduit connection between the conduit system and the terminal box of the motor or the conduit connection point of the equipment.

B. Conduits installed in the conduit system shall be terminated in such locations as to permit direct connections to motors, devices or equipment.

C. Connections shall be made with rigid conduit if equipment is fixed and not subject to adjustment, mechanical movement or vibration. Rigid connections shall be provided with union fittings to permit removal of equipment without cutting, breaking or burning conduit.

D. Motors, transformers and equipment subject to adjustment, mechanical movement or vibration shall be connected with flexible metallic conduit.

E. Devices such as solenoid valves, small limit switches, etc., shall be connected with flexible metallic conduit arranged to prevent strain and distortion.

F. Flexible conduit connections shall be watertight unless the area of installation requires explosion-proof construction.

3.4 INSTALLATION OF BOXES AND FITTINGS

A. All concealed outlet boxes shall be set in such a manner that they will be plumb and flush with the finished surface.

B. Boxes shall be installed rigidly and securely to the structure. Independent supports shall be provided where no walls or other structural surface exists.

C. Expansion and expansion/deflection fittings shall be installed where conduits cross structural expansion joints and at locations shown on the Contract Drawings. Fittings shall be installed on each conduit and incorporated into the expansion joints of structures, at right angles to the joint, to insure their proper functioning and preservation.

D. Expansion fittings shall be installed on exposed conduit runs exceeding 200 feet. Unless specifically shown otherwise on the Contract Drawings or stated in the Specifications, when crossing structural expansion joints larger than one inch, an expansion fitting shall also be installed together with an expansion/deflection fitting. The fittings shall be installed on each conduit run in accordance with manufacture's recommendations to provide the additional movement necessary.

E. All conduit connections in wet and corrosive locations shall be made up watertight and shall terminate at enclosures with an approved conduit hubs.

F. All conduit connections in dry and dusty locations shall terminate at enclosures with bushings and lock nuts. Terminations shall include one bushing and two lock nuts at each location. Lock nuts shall be installed one inside and one lock nut outside the enclosure. All conduit shall be bonded to the safety ground.

G. At pull and junction boxes having any box dimension in excess of 18 inches, jumper type grounding bushings shall be installed on conduit ends and jumper wires shall be installed to bond all conduits and to bond conduits to boxes.

H. All insulated grounding bushings shall be bonded together and to the structure of the enclosure by a continuous, copper bonding wire.

I. Removable, flame-retardant, insulating cable supports shall be provided in all boxes with any dimension exceeding 3 feet.

J. Scratched PVC boxes damaged as a result of installation shall be touched up by field applying PVC. All touch up work shall be in strict conformance with manufacturer's recommendations.

3.5 INSTALLATION WITHIN HAZARDOUS AREAS

A. Explosion-proof boxes and fittings shall be of a type approved by the Engineer. Boxes and fittings shall be of cast iron with finish as specified hereinbefore or of an aluminum alloy specially developed for use in hazardous areas.

B. Explosion-proof boxes shall be suitable for the installation of explosion-proof switches, receptacles, lighting fixtures or other devices as indicated. All conduit connections to such boxes shall be made with threaded fittings. Bushings and locknut connections shall not be used.

C. Conduits terminating at explosion-proof boxes, enclosing circuit opening equipment, shall be sealed at the entrance to the box with an approved compound-filled sealing fitting to prevent passage of explosive or combustible gases through the conduit. Where construction prevents the use of sealing fittings, the ends of the conduits shall be properly sealed with sealing compound.

D. Sealing fittings shall be installed to seal each conduit leading from or entering into hazardous locations. Exposed conduits passing through hazardous locations shall be sealed at point of exit and entrance.

E. The installation of explosion-proof boxes, fittings and all conduits in connection therewith shall conform to the requirements of the National Electrical Code for Class I, Division 1 Group D hazardous location unless specifically noted otherwise.

3.6 FIELD TESTS

A. After installation, the electric conduit system shall be field tested. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide testing consisting of the following:
   1. Each conduit shall be tested by pulling through a cylindrical mandrel as specified under paragraph 3.2 K. Maintain a record of all conduits testing clear.
   2. Conduit systems shall be ground tested in the presence of the Engineer, who will inspect all enclosures, pull and junction boxes for bonding to the safety green conductor pulled with the nominal 120 volt and higher power and control circuits, and for bonding of the conduit grounding bushing to this safety ground.
   3. The separation of above safety grounding system from the instrumentation signal grounding shall be verified.

B. The Contractor shall provide a Field Test Report. The Report shall identify the testing performed and the results obtained.

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SECTION 16133

UNDERGROUND DUCTS – DUCTS IN CONCRETE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing underground ducts. Underground ducts shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. Underground ducts shall be concrete encased. The Contractor shall provide reinforced concrete encasement for the duct system.

C. The Contractor shall perform all excavations and backfilling, as required, unless specifically shown otherwise on the Contract Drawings or stated in the Specifications.

1.2 RELATED SPECIFICATIONS

A. Specification 02200 – Earthwork

B. Specification 02500 – Surface Restoration

C. Specification 03300 - Cast-in-Place Concrete

D. Specification 05120 - Structural Steel

E. Specification 16061 - Grounding

F. Specification 16131 - Electric Conduit System

1.3 PAYMENT

A. Payment for all work for underground ducts shown on the Contract Drawings and specified herein shall be included in the lump sum price bid for Contract Item 1. Payment for additional conduit, required by changes from that shown on the Contract Drawings or specified, will be made at the unit prices bid for additional conduit as described in the General Conditions and as specified under Division 1 of the Specifications.

1.4 REFERENCES

A. Underground ducts shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. National Electrical Safety Code.
   3. UL No. 651, Schedule 40 and 80 PVC conduit.
   4. NEMA TC2, Electrical Plastic Tubing, Conduit and Fittings.
   5. UL No. 1684, Reinforced Thermosetting Resin conduit.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Prior to equipment submission, submit a list of proposed manufacturers with the products they produce proposed for the contract.
   2. Manufacturer's Literature with manufacturer's name, designation and catalog number for all products proposed for the underground duct system.
   3. Scaled Working Drawings showing the routing of the duct banks and the location of manholes, handholes and the principal outline of buildings and structures. Reference duct banks dimensionally from fixed objects or structures. Include profiles of duct banks showing crossings with piping and other underground systems.

1.6 DELIVERY, STORAGE AND HANDLING

A. Underground ducts shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's instructions.

PART 2 - PRODUCTS

2.1 RIGID STEEL CONDUIT

A. Steel conduit for ducts shall be in accordance with the requirements of Specification 16131 - Electric Conduit System, except PVC coating of conduit is not required. Steel conduit shall be used for all medium voltage systems, instrumentation systems and communication systems throughout the underground system.

2.2 NON-METALLIC CONDUIT AND FITTINGS

A. Non-metallic conduit for ducts shall be PVC plastic or fiberglass-reinforced epoxy for all 600V systems.
   1. PVC plastic conduit shall be Schedule 40, NEMA type EPC-40-PVC, rated 90 degrees C, conforming to UL No. 651.
   2. Reinforced thermosetting resin conduit and fittings shall conform to UL No. 1684. Both conduit and fittings shall consist of 68 percent glass content encapsulated in an epoxy matrix.

B. All non-metallic fittings, elbows, bodies, terminations, expansions and fasteners shall be the same material and manufacturer as the conduit.

C. PVC conduit shall be by Carlon, Amoco or approved equal. Fiberglass-reinforced epoxy conduit shall be by FRE conduit, A.O. Smith or approved equal.

2.3 CONDUIT SPACERS

A. Conduit spacers shall be nonmetallic, interlocking type to maintain spacing between conduits. Spacers shall be suitable for all types of conduit in multiple sizes.

2.4 WARNING RIBBON

A. Warning ribbon shall be a three inch wide, four mil polyethylene or polyvinyl chloride tape. The tape shall be permanently imprinted in red color, "CAUTION BURIED ELECTRIC LINE BELOW."

B. Warning tape shall be by Seton, Ideal Industries or approved equal.

2.5 DUCT SEAL

A. Duct seal for conduits shall be in accordance with the requirements of Specification 16131 - Electric Conduit System.

2.6 REINFORCED CONCRETE

A. Concrete for envelope shall be Class 40 concrete in accordance with the requirements of Specification 03300 - Cast-in-Place Concrete. Steel reinforcement shall be in accordance with the requirements of Specification 05120 - Structural Steel.

2.7 EXPANSION AND DEFLECTION FITTINGS

A. Where specifically shown on the Contract Drawings, expansion and deflection fittings shall be provided at the structural joints of the underground duct system.

B. Expansion and deflection fittings shall be in accordance with Specification 16131 - Electric Conduit System.

2.8 CONDUIT BUSHINGS

A. Conduit bushings shall be provided for the termination of rigid steel conduits at each manhole.

B. Conduit bushings shall be in accordance with Specification 16131 - Electric Conduit System.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The duct system shall be installed to avoid interferences with structures, piping and other underground systems. Terminate ducts with insulated grounding bushings at manholes and handholes. Conduit ducts shall be sized, arranged and installed in a reinforced concrete envelope as shown on the Contract Drawings.

B. Trenches for duct banks shall be in accordance with the requirements of Specification 02316 - Excavation. Duct bank trenches shall have the bottom tamped firm and even, and suitably braced side forms shall be employed in forming the envelope.

C. Duct banks shall follow straight lines as far as possible. Where deviation from a straight line becomes necessary, offsets shall be made using 5 degree angle coupling or make bend with sweeps. The sweep radius shall be 36 inch for 90 and 45 degree bends and 30 inch for 30 degree bends. Where directed by the Engineer, bends shall be made up with standard factory bends or other approved curved sections.

D. Duct bank installations and penetrations through foundation walls shall be made watertight.

E. Duct banks shall be assembled using non-magnetic saddles, spacers and separators. Separators shall be positioned to provide 3-inch minimum concrete separation between the outer surfaces of the ducts.

F. Concrete covering shall be provided on both sides, top and bottom of the concrete envelopes around conduits. Concrete covering shall be in accordance with the

detail shown on the Contract Drawings. Top of concrete encasement shall not be less than thirty inches below finish grade. Add red dye to concrete used for envelopes or trowel a coloring on the concrete for easy identification during subsequent excavation.

G. Before pouring concrete, written approval shall be obtained from the inspecting engineer.

H. Ducts shall be firmly fixed in place during pouring of concrete. Concrete shall be carefully spaded and vibrated to insure filling of all spaces between ducts.

I. A transition shall be made from non-metallic to rigid steel conduit where duct banks enter structures or turn upward for continuation above grade. Rigid steel ducts shall be terminated using insulated grounding bushings. Ducts inside buildings shall be continued using rigid steel or PVC coated rigid steel conduits as required for the area.

J. Ducts entering manholes and hand holes shall be terminated using suitable end bells. Rigid steel ducts shall be terminated using insulated grounding bushings.

K. Backfilling for duct banks shall be in accordance with the requirements of Specification 02317 - Backfilling. Backfilling shall be permitted when directed by the engineer to proceed. Backfilling shall not be with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material or other materials which can damage or contribute to corrosion of ducts or cables or prevent adequate compaction of fill.

L. Duct runs shall be sloped for drainage toward manholes and away from buildings with a slope of approximately 3 inches per 100 feet.

M. A ground cable shall be installed in each duct bank envelope. Cable shall be in accordance with the requirements of Specification 16061 - Grounding. The ground shall be made electrically continuous throughout the entire duct bank system. Ground cable shall be connected to the building, station ground grid, equipment ground buses and to each conduit grounding bushing of the underground duct system. The ground cable shall be terminated at the last manhole or handhole for outlying structures.

N. After installation each conduit in each duct bank shall be cleaned and cleared of obstructions and foreign matter by rodding and by the passage of cleaning brushes or cutting mandrels. After cleaning, the clearance of each conduit shall be checked by passing a 12 inch long mandrel, of diameter 1/2 inch less than the

nominal duct diameter, through the entire length of duct run. Ducts which do not permit passage of the mandrel shall be cleared, cut out and replaced or sealed and replaced by additional construction. The duct bank conduit cleaning shall be included in the electric conduit system field test report specified in Specification 16131 - Electric Conduit System.

O. A warning ribbon shall be installed approximately 12 inches below finished grade over all underground duct banks carrying cables of 480 volts and higher.

P. All ducts entering buildings and structures shall be sealed. All empty spare ducts shall be sealed and plugged.

Q. An expansion and deflection fitting shall be installed on each conduit at each of the structural expansion joints when shown on the Contract Drawings. Joints shall be located as defined by the criteria noted on the Contract Drawings.

+ + END OF SECTION + +

SECTION 16134

ELECTRIC MANHOLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing electric manholes. This section also includes requirements for providing electric handholes. Electric manholes and handholes shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The Contractor shall perform all excavations, complete all forms, and do backfilling and tamping, as required, unless specifically shown otherwise on the Contract Drawings or stated in the Specifications.

1.2 RELATED SPECIFICATIONS

A. Specification 02200 - Earthwork

B. Specification 02500 – Surface Restoration

C. Specification 03400 – Pre-Cast Concrete

D. Specification 05120 - Structural Steel

E. Specification 05540 - Metal Castings

F. Specification 16061 – Grounding

1.3 PAYMENT

A. Payment for electric manholes and handholes shall be made as provided for in the General Conditions and as specified under Division 1 of the Specifications..

1.04 REFERENCES

A. Electric manholes and handholes shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. National Electrical Safety Code.
   3. Long Island Power Authority.

1.05 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Prior to equipment submission, submit a list of proposed manufacturers with the products they produce proposed for the contract.
   2. Manufacturer's technical information for manholes, handholes and accessories proposed for use.
   3. Drawings showing interior and exterior dimensions and details of openings, jointing, inserts and reinforcing.

C. Structural Design Calculations:
   1. Structural design calculations sealed by a P.E. registered in the State of New York. Design calculations for manholes shall include confirmation structures adequately resist flotation when they are totally empty and subjected to groundwater full height of structure.

1.6 DELIVERY, STORAGE AND HANDLING

A. Electric manholes and handholes shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manholes and handholes shall be pre-cast type of reinforced concrete. Where specifically shown on the Contract Drawing or stated in the Specifications, the use of cast-in-place type manholes and handholes shall be permitted.

B. Manholes associated with the LIPA service feeders shall be in accordance with the requirements of Long Island Power Authority.

C. Concrete for manholes and handholes shall be Class 40 concrete in accordance with the requirements of Specification 03400 – Pre-Cast Concrete. Manholes and handholes shall be constructed to withstand ground water pressure when completely submerged by rising water table.

D. Steel reinforcement shall be as shown on the details on the Contract Drawings and shall be in accordance with the requirements of Specification 05120 - Structural Steel.

E. Manholes and handholes shall have dimensions as shown on the Contract Drawings and shall be provided with all duct entrances sized and located to suit duct banks.

F. Concrete floor shall be sloped towards the drain sump at the center of each manhole and handhole.

G. All manhole and handhole hardware shall be hot dipped galvanized steel.

H. Minimum structural design loading for manholes shall be as indicated in ASTM C857, unless otherwise noted herein. Manholes subjected to vehicular traffic shall be designed for H-20 traffic loading. Other manholes shall be designed for a vertical live load of 300 psf.

I. Walls of manholes shall be designed for a minimum vertical surcharge of 100 psf.

J. Manholes shall be designed to resist flotation when totally empty and subjected to groundwater full height of the manhole.

2.2 FRAMES AND COVERS

A. Each manhole and handhole shall be provided with a cast-iron watertight manhole frame with inside and outside covers.

B. All frames and covers shall be in accordance with the requirements of Specification 05561 - Miscellaneous Metal Castings. Frames and covers shall be annealed, high quality, gray cast iron, free from blowholes, sandholes, scabs, fins, scales and other defects. They shall be uniform in form and dimensions, and shall be as approved by the Engineer.

C. The frames shall be so set that the completed installation will provide a proper alignment of the outside covers with the roadways or other surrounding areas. Manhole and handhole covers shall fit the frame without undue play.

D. The following words shall be cast in the top of all manhole and hand hole covers, as appropriate.
   1. "ELECTRIC POWER, LOW VOLTAGE"
   2. "ELECTRIC POWER, MEDIUM VOLTAGE"
   3. "COMMUNICATIONS / INSTRUMENTATION"

   The words "ELECTRIC", TELEPHONE", "COMMUNICATION" and "FIRE ALARM" shall be cast in the top of all power, telephone, communication and fire alarm manhole and hand hole covers respectively.

2.3 CABLE SUPPORTS

A. Manholes shall be furnished with cable racks, cable hooks and insulators to effectively support all cables indicated for present and future installation. Cable racks shall be made from steel channel with ample strength to support cables. Racks shall be firmly anchored to walls. Cable hooks shall be made from malleable iron. Racks and hooks shall have hot-dipped galvanized finish. Insulators shall be made of high-grade dry-process porcelain with smooth glazed surfaces and shall fit hooks in such manner as to prevent wobbling and insure minimum movement.

2.4 PULLING IRONS

A. Galvanized steel pulling irons shall be provided for each manhole and handhole. Pulling irons shall be cast in the wall opposite to the centerline of each incoming duct bank and 12 inches below centerline of bottom line of ducts.

2.5 GROUNDING

A. Each manhole shall be provided with a grounding system. The grounding system shall consists of grounding rod and cable in accordance with the details shown on the Contract Drawings.

B. Ground rod and cable shall be in accordance with the requirements of Specification 16061 - Grounding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Manholes and handholes shall be installed where shown on the Contract Drawings. Except where handholes are directly supported by utility supports, place each manhole and handhole on a 12-inch select fill base and make level.

B. Manhole and handhole excavation shall be in accordance with the requirements of Specification 02316 - Excavation. Backfilling for manholes and handholes shall be in accordance with the requirements of Specification 02317 - Backfilling.

C. Manhole and handhole installation shall be completed so that structure is watertight. Two coats of bituminous waterproofing material shall be applied to exterior surface of each manhole and handhole. A waterproof gasket shall be provided all around removable precast manhole cap.

D. Cable racks shall be installed within each manhole for the support of cables. Cable racks shall be in accordance with the following:

1. Attach racks with 3-inch by 3/8-inch diameter "tamp-in" studs mounted in 1-inch holes drilled into walls of manholes in the absence of inserts. Apply PVC coating to all racks.

2. Provide cable hooks to support each cable on each rack along the cable run within the manholes. Apply PVC coating to all hooks.

3. Individually support each cable at each hook on porcelain insulators. Provide sufficient slack for each cable.

4. In the manhole securely tie each cable in place at each insulator block to prevent excessive movement of insulators, cables, or fireproof tape. Tie cables with non-metallic 3/4-inch strapping tape as manufactured by 3M or tie down with nylon straps.

E. A grounding system shall be installed for each manhole. All exposed metal, manhole frame and cover, accessories and the concrete reinforcing rods shall be bonded with No. 4 AWG minimum bare copper wire and connected to the duct bank ground in accordance with the details shown on the Contract Drawings.

F. Concrete curb shall be provided for manholes when required to adjust manhole cover to proper grade. Curb shall be constructed on the roof slab or cone section on which the manhole frame and cover shall be placed. The height of the curb shall be such as is necessary to bring the manhole frame to the proper grade.

G. For cast in place type manholes and handholes, pulling irons shall be set and other built-in items shall be in place before placing concrete.

+ + END OF SECTION + +

SECTION 16261

UNINTERRUPTIBLE POWER SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing uninterruptible power system. Uninterruptible power system shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The uninterruptible power system required under this section shall be the continuous on line type with power ratings from 500 to 300,000 volt-ampere.

1.2 RELATED SPECIFICATIONS

A. Specification 16036 - Testing

B. Specification 16076 - Labeling and Identification

1.3 PAYMENT

A. Payment for uninterruptible power system shall be made as provided for in the Specifications.

1.4 REFERENCES

A. Uninterruptible power system shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. IEEE C62.41, Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits.
   3 IEEE C62.45, Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits.
   4. ANSI C84.1, Electrical Power Systems and Equipment - Voltage Ratings.
   6. UL Standard No. 1449, Transient Voltage Surge Suppressors.
   7. UL Standard No. 1778, Uninterruptible Power Supply Equipment.

1.5 SYSTEM DESCRIPTION

A. Each uninterruptible power system shall be self-contained in a compact package.

B. The uninterruptible power system shall consist of an inverter, a precision float battery charger, a sealed, maintenance free battery and a bypass switch to provide the following operation.
   1. Under normal operating conditions, the critical load shall be powered by normal AC line supply that has been filtered through surge protection filters. When AC line power is present the inverter shall be normally off.
   2. When AC line power fails or goes out of tolerance, the inverter shall supply AC power from the battery source. There shall be no break in the output of the system during transfer from normal AC line supply to inverter battery supply or from the battery supply back to the AC line supply.
   3. Under the UPS position, the bypass switch shall connect the conditioned output to the load. When the line position is selected, the bypass switch shall connect the input line directly to the load.

1.6 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Prior to equipment submission, submit name of the proposed manufacturer and location of closest service office from which this equipment shall be serviced and location of closest parts inventory.
   2. Manufacturer's catalog cuts and technical information required to demonstrate compliance with the specific requirements.
   3. A completed materials list showing all items proposed for use.
   4. Control and wiring diagrams with construction details of enclosures.
   5. Description of shop and field testing methods and procedures. Testing methods and procedures shall be submitted at least 45 days prior to conformation of witness testing dates and actual testing.
   6. Qualifications of proposed service firm who will perform the service and maintenance agreement. Five recent references with phone numbers shall be submitted.

C. Shop and field test reports shall be submitted.

D. Operation and Maintenance Manuals shall be submitted in accordance with the Specifications.

1.7 QUALITY ASSURANCE

A. General:
   1. The uninterruptible power system shall be designed, built and tested in accordance with the latest applicable editions of ANSI/IEEE, NEMA, UL, and NFPA. The uninterruptible power system shall be UL listed.

   2. The uninterruptible power system shall provide a reliable source of isolated, regulated uninterruptible power with no break in AC output power during a complete or partial interruption of incoming line power.
   3. The uninterruptible power system manufacturer shall have experience in the design and be regularly engaged in manufacturing, and servicing equipment for installations of the type and size specified under this section.
   4. The uninterruptible power system manufacturer shall use a shop test facility that has qualified, experienced technicians, for all shop tests.

B. Field Tests:
   1. The uninterruptible power system shall be field tested. Field testing shall be performed in accordance with the requirements specified under Article 3.02.
   2. Retain the services of the uninterruptible power system manufacturer for field service. Field service shall be in accordance with the requirements specified under Article 3.03.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The uninterruptible power system equipment shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's recommendations.

1.09 SERVICE AND MAINTENANCE AGREEMENT

A. The uninterruptible power system manufacturer guarantee shall include all equipment furnished under this Section against defects in workmanship and material for a period of twelve (12) months from the date of final acceptance of the equipment. After the twelve month guarantee period expires, the Contractor shall furnish a Service and Maintenance Agreement for a period of three (3) years beyond the guarantee period.

B. All costs for labor, transportation, freight and replacement parts required to satisfactorily repair any piece of equipment as a result of equipment malfunction during the guarantee period shall be considered to have been included in the lump sum price bid for providing the uninterruptible power system.

C. The Service and Maintenance Agreement shall cover maintenance as well as emergency repairs. The agreement shall at a minimum include the following:

1. All maintenance recommended by the manufacturer including checkout, inspection and maintenance of all furnished components and wiring once per year.
2. All parts, labor, and other expenses associated with providing emergency (within 48-hours) on-site repairs, regardless of the reason for failure excepting misuse or vandalism.
3. A report shall be submitted after each site visit describing the problem, solution, all work performed and parts replaced.

D. All work covered by the service and maintenance agreement shall be performed by the uninterruptible power system manufacturer or authorized representative. The cost of this agreement shall be included in the lump sum price bid for the uninterruptible power system.

1.10 SPARE PARTS

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the uninterruptible power systems in accordance with the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts shall be furnished and shall include one set for every four systems installed per power rating. Each spare part set shall consist of the manufacturer's complete line of recommended spare parts inventory and shall include at a minimum the following:
1. One set of fuses shall be provided of each size and type used.
2. One set of boards including interface, connection, fuse, display, driver, power supply with accessories shall be provided.
3. One set of modules including static switch assembly with accessories shall be provided.
4. One set of current monitor boards and contactor including inverter, I/O and DC with accessories shall be provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Uninterruptible power systems shall be manufactured by Eaton, Controlled Power Company or approved equal.

2.2 SYSTEM FEATURES

A. General:
   1. The uninterruptible power system shall be of the ferroresonant transformer type that provides a continuously filtered, no-break output supply to the protected load.
   2. The uninterruptible power system shall have active voltage regulation suitable to work with varying input sources.
   3. The uninterruptible power system shall be computer load compatible suitable for the demands of computer type loads including power factor corrected, switch-mode and linear power supplies.
   4. The uninterruptible power systems shall be single phase with a nominal frequency of 60 Hz. Power ratings, nominal input and output voltages shall be as shown on the Contract Drawings.
   5. The uninterruptible power system enclosure shall have identifying nameplates in accordance with the requirements of Specification 16076 - Labeling and Identification.

B. Operating Criteria:
   1. The uninterruptible power system's operating criteria shall be in accordance with the following:
      a. Ambient temperature range shall be 0 degrees C to 40 degrees C.
      b. Operational humidity shall be up to 95 percent non-condensing.
      c. Maximum altitude shall be 3,000 feet above sea level with a maximum ambient temperature drop of 1 degree C per 1,000 feet.
      d. Voltage regulation shall be plus or minus 3 percent for input voltages from plus fifteen to minus twenty percent of nominal.
      e. Overload capability shall be 150 percent surge and 125 percent for 10 minutes when operating on line, 150 percent surge and 110 percent on inverter.
      f. Nominal frequency shall be 60 hertz with adjustable tracking limits of .01 to 3 hertz.
      g. Power supply shall be computer grade sine wave with 5 percent or less total harmonic distortion at rated load.
      h. Efficiency shall be 85 percent minimum.

C. Protection: The uninterruptible power system shall have protective functions in accordance with the following.
   1. Lightning and surge protection shall provide 2,000 to 1 spike attenuation.
   2. Noise rejection shall provide common mode greater than 120 dB and normal mode greater than 60 dB.
   3. Surge protection filter shall provide current limiting overload protection.
   4. Fuses shall provide over current protection for DC and battery charger circuits.
   5. Remote emergency off shall shutdown the output supply to the load when activated from an external switch.

D. Accessories: The uninterruptible power system shall have accessories in accordance with the following.
   1. Batteries shall supply a source of DC. Batteries shall be sealed, maintenance free lead calcium type. The batteries shall provide a minimum of 9 minutes at full load and 25 minutes at one half load. Batteries shall be enclosed in the system cabinet or a separate cabinet when necessary.
   2. A maintenance bypass switch and AC input disconnect shall be provided. The switches shall be suitable rated for bypassing the condition power to supply the load and to isolate the input AC from the unit. The bypass switch shall be made before break type. The switches shall be suitable for mounting within the system cabinet or a separate cabinet when necessary.
   3. A microprocessor based status and control display unit shall be provided for operator interface. The unit shall be mounted on the front of the system cabinet and shall provide monitoring and display of the manufacturer's standard metered and alarm functions.
   4. A RS-232 communication interface shall be provided for remote transmission of the manufacturer's standard metered and alarm functions. An alarm dry contact output shall also be provided that close upon any alarm condition.
   5. Unless shown otherwise on the Contract Drawings or stated in the Specifications input and output connections shall be provided based upon the manufacturer's standard arrangement. The connections shall be cord and plug or hardwire input with receptacles or hardwire output as shown on the Contract Drawings.

2.3 CERTIFIED SHOP TESTS

A. Shop testing shall be performed on each uninterruptible power system at the manufacturer's plant prior to shipment. Shop tests shall demonstrate that the equipment conforms to the requirements specified.

B. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained. The tests shall include the manufacturer's standard tests and the following at a minimum:
   1. Operational test to ensure proper operation of the components and sequence of operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The uninterruptible power supply system shall be installed as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

B. Install nameplates for identification of equipment.

3.2 FIELD TESTS

A. After installation, uninterruptible power systems shall be field tested for operation and conformance. The Contractor shall perform field testing in accordance with the Specifications. The field tests shall be witnessed by the Engineer and certified by the Contractor.

B. Testing shall be performed by the manufacturer's representative, prior to energizing equipment. The testing shall be in accordance with the recommendations of the manufacturer's representative. Equipment shall not be energized without the permission of the Engineer.

3.3 MANUFACTURER'S FIELD SERVICES

A. A qualified manufacturer's representative shall assist in the installation of the uninterruptible power systems, check the installation before it is placed into operation, assist in the performance of field tests, observe and assist initial operations and train the plant operations and maintenance staff in the care, operation and maintenance of the uninterruptible power systems.

B. The Contractor shall provide equipment start-up services and training in accordance with the Specifications.

C. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, test results, training, instruction and all other pertinent information.

D. The service representative shall sign in with the Engineer on each day they are at the site.

+ + END OF SECTION + +

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SECTION 16271

DRY TYPE TRANSFORMER

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing dry type transformers. Dry type transformers shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

1.2 RELATED SPECIFICATIONS

A. Specification 16036 - Testing

B. Specification 16076 - Labeling and Identification

1.3 PAYMENT

A. Payment for dry type transformers shall be included in the lump sum price bid for this Contract.

1.4 REFERENCES

A. Dry type transformers shall comply with the latest applicable provisions and recommendations of the following:

1. NFPA 70, National Electrical Code.

2. ANSI C89.1, Specialty Transformers.

3. ANSI C89.2, Dry-Type Transformers for General Applications.

4. UL Standard No. 506, Specialty Transformers.

5. UL Standard No. 1561, Dry-Type General Purpose and Power Transformers.

6. NEMA ST-20, Sound Levels.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:

1. Manufacturer's catalog cuts for the transformers proposed for use.

2. Dimensional drawings showing transformer details with diagrammatic nameplate.

3. Description of shop and field testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least 45 days in advance prior to conformation of witness testing dates and actual testing.

C. Field Tests

1. The medium voltage solid state starters shall be field tested. Field testing shall be performed in accordance with the requirements specified under article 3.02.
2. The services of the medium voltage solid state starters manufacturer shall be retained for field service. Field service shall be in accordance with the requirements specified under Article 3.03.
3. Retain the service of an independent testing firm who shall perform field acceptance testing of the medium voltage solid state starters. The testing firm shall have experience in the inspection and testing of the equipment and shall be a member company of NETA. Provide proof of membership, or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer. Acceptance testing shall be in accordance with the requirements specified under Article 3.04.
4. Shop test and field test reports shall be submitted.

D. Operations and Maintenance Manuals shall be submitted in accordance with the Specifications.

1.6 QUALITY ASSURANCE

A. General:

1. All transformers shall conform to the applicable NEMA, ANSI and IEEE Standards and shall be built by one approved manufacturer who shall use only best commercial materials and processes of manufacture.

Transformer enclosures shall have ample room for primary and secondary wiring connections.

2. All transformers shall be UL listed and certified to ANSI/NEMA sound levels.

3. The transformer manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all shop tests. Calibration of testing apparatus shall be within one year.

4. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology.

B. Field testing of the transformers shall be performed in accordance with the requirements specified under Article 3.02.

1.7 DELIVERY, STORAGE AND HANDLING

A. Dry type transformers shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's recommendations.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Dry type transformers shall be manufactured by Eaton, ABB, Square D or approved equal.

A. General purpose transformers shall be of the dry, commercially quiet, low temperature rise type consisting of two copper windings per phase. Transformers shall be suitable for indoor or outdoor installation in accordance with the locations shown on the Contract Drawings.

B. Transformers shall have KVA rating, primary voltage and connection, secondary voltage and connection and number of phases as shown on the Contract Drawings.

C. Transformer insulation shall be rated 220 degrees C, 80 degrees C rise.

D. Transformers shall be equipped with six 2-1/2 percent fully rated taps, two above and four below the rated voltage tap on the primary winding. The arrangement, assembly, and laminations of the core shall be such as to facilitate

repair to the windings. The design, shape, and arrangement of windings shall allow free flow of air for insulation and cooling.

2.2 RUBBER MATS

A. Contractor shall furnish and install floor mats. Floor mats shall be of prime quality rubber compound, free of calendering and curing defects and shall be resistant to weather, aging and ozone in normal concentrations. Mats shall be 5/8-inch thick and shall be custom made to sizes shown with beveled edges.

B. Floor mats shall be furnished and installed along the entire front, back and side of each transformer furnished and installed under this Contract.

C. Mat shall be black with yellow safety stripe on edge as manufactured by American Floor Mats, series double-duty anti-fatigue mats.

2.3 SHOP TESTS

A. Shop tests shall be performed at the transformer's manufacturer's plant prior to shipment. Shop tests shall demonstrate that the equipment tested conforms to the requirements specified.

B. Each transformer shall be given a routine test in accordance with the latest requirements of UL, ANSI and NEMA standards.

C. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

D. Transformer shop tests shall be performed consisting of the following:

1. Applied potential shall be performed.
2. Induced potential shall be performed.
3. No load losses shall be performed.
4. Voltage ratio shall be performed.
5. Polarity shall be performed.

PART 3 EXECUTION

3.1 INSTALLATION

A. Transformers shall be installed on walls or floors. Floor mounted transformers shall be installed on one inch of Korfund sound absorber material on raised concrete base at locations shown on the Contract Drawings. Sufficient access and working space shall be provided for ready and safe operation and maintenance.

B. The transformer leads shall be provided with solderless, clamp type cable connectors. Conduit runs shall be arranged for easy removal of the transformers.

C. Transformer nameplates shall be Install for identification of equipment. Nameplates shall be provided in accordance with the requirements of Specification 16076 - Labeling and Identification.

3.2 FIELD TESTS

A. Insulation resistance tests shall be performed on the transformers after installation. The tests shall be witnessed by the Engineer and certified by the Contractor. The tests shall be performed by the Contractor who shall furnish all testing equipment.

B. The Contractor shall provide a field test report. The report shall identify the tests performed and the results obtained.

+ + END OF SECTION + +

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SECTION 16281

POWER FILTERS AND CONDITIONERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing power filters and conditioners. Power filters and conditioners shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The power filters required under this section shall be the transient voltage surge suppression type for filtering transients from low voltage AC power circuits.

C. The power conditioners required under this section shall be the constant voltage transformer type for regulation and conditioning low voltage AC power circuits.

1.2 RELATED SPECIFICATIONS

A. Specification 16036 – Testing

B. Specification 16076 - Labeling and Identification

1.3 PAYMENT

A. Payment for power filters and conditioners shall be made as provided for in the Specifications.

1.4 REFERENCES

A. Power filters and conditioners shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. NEMA Standard No. LS1.
   3. UL Standard No. 544, Medical and Dental Equipment.
   4. UL Standard No. 1012, Power Units Other Than Class 2.
   5. UL Standard No. 1283, Electromagnetic Interference Filters.
   6. UL Standard No. 1449, Transient Voltage Surge Suppressors.
   7. IEEE C62.41, Recommended Practice On Surge Voltages In Low-Voltage AC Power Circuits.
   9. IEEE C62.45, Guide On Surge Testing For Equipment Connected to Low-Voltage AC Power Circuits.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Prior to equipment submission, submit a list of proposed manufacturers with the products they produce proposed for the contract.
   2. Manufacturer's catalog cuts and technical information required to demonstrate compliance with the specific requirements.
   3. Wiring diagram with construction details of enclosure.

C. Certificates of Compliance: Certified documentation of UL 1449 Second Edition listing, from the transient voltage surge suppressor manufacturer.

D. Reports:
   1. Transient voltage surge suppressor shop test reports shall be submitted. Shop test reports shall include test data verifying let through voltage, surge current rating and noise attenuation.
   2. Manufacturer's field report shall be submitted.

E. Operation and Maintenance Manuals shall be submitted in accordance with the Specifications.

1.6 QUALITY ASSURANCE

A. General:
   1. Power filters and conditioners shall be designed, built and tested in accordance with the latest applicable editions of NEMA, ANSI/IEEE, UL and NFPA. Power filters and conditioners shall be UL listed.
   2. The power filters and conditioner manufacturers shall have experience in the design and be regularly engaged in manufacturing, and servicing equipment for installations of the type and size specified under this section. The power filter manufacturer shall be a member company as listed by NEMA Standard No. LS1. Provide proof of membership, or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer.
   3. The power filter and conditioner manufacturers shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing. The Quality Assurance Program shall be the manufacturer's standard program specifically dedicated to ensure each power filter and conditioner is designed, assembled and tested in accordance with the requirements specified.

4. The transient voltage surge suppressors shall be tested and suitable for IEEE C62.41 category C environments.

B. Field Service: Retain the services of the power filter manufacturer's for field service. Field service shall be in accordance with the requirements specified under Article 3.02.

1.7 DELIVERY, STORAGE AND HANDLING

A. The power filters and conditioners shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's recommendations.

1.8 WARRANTY PROVISIONS

A. The power filter manufacturer guarantee shall include all components of the system against defects in workmanship and materials for a period of 5 years.

B. When non- module design type construction is used for power filters at service entrance locations, the entire system shall be guaranteed for a period of 10 years.

1.9 SPARE PARTS

A. Spare parts are required for power filters, whenever module type designs are used at service entrance locations.

B. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the power filter in accordance with the Specifications.

C. The spare parts shall be furnished with one complete set of modules for each power filter located at each service entrance. The modules shall be packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number and complete information for reordering.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The transient voltage surge suppressors shall be manufactured by Advanced Protection Technology, Innovative Technology or approved equal.

B. The power conditioners shall be manufactured by Sola, Controlled Power Company or approved equal.

2.2 TRANSIENT VOLTAGE SURGE SUPPRESSORS

A. General:
   1. Transient voltage surge suppressors shall be rated for the nominal operating voltage, unit configuration and location category based upon the system requirements shown on the Contract Drawings. Location categories shall be in accordance with IEEE C62.41.
   2. The transient voltage surge suppression circuitry shall be metal oxide varistor based with a balanced suppression platform to ensure equal stressing and maximum performance.
   3. Transient voltage surge suppressors shall be designed with non - module type construction. At service entrance locations, transient voltage surge suppressors may also be designed with module type construction.
   4. For a wye configured systems, the suppressor shall have directly connected suppression elements between line-neutral, line-ground and neutral-ground. For a delta configured systems, the device shall have suppression elements between line to line and line to ground.
   5. Each suppressor device shall be enclosed in a NEMA type 12 enclosure. The enclosure shall have identifying nameplates in accordance with the requirements of Specification 16076 - Labeling and Identification.

B. Operating Criteria:
   1. The suppressor device shall have a maximum continuous operating voltage 115 percent greater than the nominal system operating voltage.
   2. The suppressor device shall have a response time of less than or equal to one nanosecond.
   3. The maximum UL 1449 let through voltage for the suppressor device at category B locations shall not exceed the following:
      a. For 208Y/120 volt systems, 400 volts line-neutral, 500V line-ground and 600V neutral-ground. 700 volts line-line.
      b. For 480Y/277 volt systems, 600 volts line-neutral, 800V line-ground and 1000V neutral-ground. 1500 volts line-line.
   4. The maximum IEEE C62.41 and C62.45 let through voltage, tested with a six inch lead length for the suppressor device shall be as follows:
      a. For category C3 surges, 208Y/120 volt systems shall be rated 600 volt line-neutral and line-ground. 800 volt neutral-ground. 900 volts line-line. 480Y/277 volt systems shall be rated 1000 volts line-neutral, 800 volt line-ground and 1300 volt neutral-ground. 1400 volts line-line.
      b. For category A3 surges, 208Y/120 volt systems shall be rated 110 volt line-neutral, 240 volt line-ground and neutral-ground. 180 volts line-line. 480Y/277 volt systems shall be rated 220 volt line-neutral, 410 volt line-ground and neutral-ground. 340 volts line-line.
   5. Each suppression device shall include a EMI/RFI noise rejection filter. Electric line noise attenuation shall be 40dB at 100 KHz.

6. The minimum total surge current that the suppression device shall be capable of withstanding shall be as follows:
    a. For service entrance equipment, category C locations, 320 KA per phase, 160 KA per mode.
    b. For distribution panelboards, category B locations, 160 KA per phase, 80 KA per mode.
    c. For branch panelboards, category A locations, 80 KA per phase, 40 KA per mode.

C. Features:
1. Each suppression device shall be equipped with a safety and diagnostic monitoring system based upon the manufacturer's standard arrangement. The system shall include the following at a minimum:
    a. Current limiting fuses, one per phase with continuous monitoring of fuses.
    b. Solid state status indicators shall be provided for each phase to indicate the faulted phase.
2. Each suppressor device shall include form C dry contacts for remote annunciation of unit status. The remote alarm shall change state should the monitoring system detect a fault condition.

2.3. SHOP TESTS

A. Certified Shop Tests:
1. Shop testing shall be performed on the power filters and conditioners at the manufacturer's plant prior to shipment. Shop tests shall include the manufacturer's standard tests and shall demonstrate quality assurance inspection and testing procedures for the equipment.
2. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power filters adjacent to panels with proper grounding in accordance with the manufacturer's recommendations at locations shown on the Contract Drawings.

B. Install power conditioners in accordance with the manufacturer's recommendations at locations shown on the Contract Drawings.

C. Install nameplates for identification of equipment.

3.2 MANUFACTURER'S FIELD SERVICES

A. A qualified representative from the power filter manufacturer shall assist in the installation of the power filters, check the installation before it is placed into operation, observe and assist initial operations and train the plant operations and maintenance staff in the care, operation and maintenance of the power filters.

B. The Contractor shall provide power filter start-up services and training in accordance with the Specifications.

C. The Contractor shall provide a field report from the power filter manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, training, instruction and all other pertinent information.

D. The service representative shall sign in with the Engineer on each day they are at the site.

+ + END OF SECTION + +

SECTION 16292

POWER DISTRIBUTION SYSTEM COORDINATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing power system studies and distribution system field testing. Power system studies and field testing shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The power system studies shall include a short circuit study, a protective device evaluation study, arc flash study, and a protective device coordination study for a completely coordinated power distribution system.

1.2 PAYMENT

A. Payment for the power distribution system coordination shall be made as provided for in the Specifications.

1.3 REFERENCES

A. The power distribution system coordination shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. ANSI Standard C37.04, Rating Structure for AC High Voltage Circuits Rated on a Symmetrical Basis.
   3. ANSI Standard C37.010, Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Basis.
   4. IEEE 141, Recommended Practice for Electric Power Distribution Industrial Plants.
   5p. IEEE 399, Recommended Practice for Industrial and Commercial Power System Analysis.

1.4 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article 4 - Contractor's Working Drawings, Design and Shop Drawings; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Calculations and results of the power system studies shall be submitted. The short circuit study, protective device evaluation and coordination studies shall be submitted in a report format. The report shall be stamped and signed by the Licensed Engineer.
   2. Work sequence for the field testing shall be submitted. The sequence shall indicate the schedule of work, time frame and downtime for the equipment. The work sequence shall be submitted at least 45 days in advance prior to conformation of field testing dates.
   3. Qualifications of proposed testing firm to perform field testing shall be submitted. Submit firm experience records at least 45 days in advance to actual testing, five recent references with phone numbers shall be submitted.

C. Reports: Field test report shall be submitted.

1.5 QUALITY ASSURANCE

A. General:
   1. The power system studies shall be performed in accordance with the latest applicable provisions and recommendations of the following:
      a. NFPA 70, National Electrical Code.
      b. ANSI C37.04.
      c. ANSI C37.010.
      d. IEEE 141.
      e. IEEE 399.
   2. The Contractor shall retain the services of a Professional Engineer, licensed in the State of New York, to perform the power system studies. The Licensed Engineer shall be from an independent consulting firm or the equipment manufacturer.

   3. The Contractor shall coordinate with the Engineer performing the studies and assist him in the collection of all information necessary to complete the studies specified.

   4. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology and the NETA maintenance testing specification.

B. Field Testing:
   1. The power distribution system shall be field tested. The field testing shall be performed in accordance with the requirements specified under Article 3.01.
   2. Retain the service of an independent testing firm who shall perform field testing of the power distribution system. The testing firm shall have experience in the inspection and testing of the system equipment and shall be a member company of NETA. Provide proof of membership, or demonstrate

that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer.

PART 2 - PRODUCTS

2.1 POWER SYSTEM STUDIES

A. General:
   1. The Contractor shall be provided with the latest power distribution system electrical study in .pdf format. The Contractor shall develop a complete power distribution system electrical study to reflect all new work performed under the scope of this project including but not limited to short circuit coordination study, protective device evaluation, arc flash study, and a protective device coordination study for the complete electrical distribution system.
   2. The studies shall include all portions of the medium and low voltage electrical distribution system from the normal and alternate sources of power through the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.
   3. Problem areas or equipment inadequacies shall be promptly brought to the Engineer's attention.

B. Short Circuit Study:
   1. The short circuit study shall be performed with the aid of a computer program. Acceptable computer programs are either SKM or ETAP.
   2. The study input data shall include the utility company's short circuit, single and three phase contributions, with the X/R ratio, the resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and all other applicable circuit parameters.
   3. Short-circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.
   4. The short circuit tabulations shall include symmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, including motor back EMF current contributions shall be listed with its respective X/R ratio.

C. Protective Device Evaluation Study:
   1. A protective device evaluation study shall be performed to determine the adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing the short-circuit ratings of these devices with the available fault currents.
   2. Appropriate multiplying factors based upon system X/R ratios and protective device rating standards shall be applied.

D. Protective Device Coordination Study:
   1. A protective device coordination study shall be performed to select or to check the selections of the power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and setting.
   2. The overcurrent device settings computed in the coordination study shall provide complete 100 percent selectivity. The system shall be selectively coordinated such that only the device nearest a fault will operate to remove the faulted circuit. System selectively shall be based on both the magnitude and the duration of a fault current.
   3. The coordination study shall include all voltage classes of equipment starting at the utility's incoming line protective device down to and including each of the medium and low voltage equipment. The phase and ground overcurrent and ground fault protection shall be included, as well as settings for all other adjustable protective devices.
   4. The time-current characteristics of the installed protective devices shall be plotted on the appropriate log-log paper. Reasonable coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a complete system basis. Sufficient curves shall be used to clearly indicate selective coordination achieved to the utility main breaker, power distribution feeder breakers, and the overcurrent devices at each major load center.
   5. There shall be a maximum of eight protective devices per plot. Each plot shall be appropriately titled. Plots shall include the following information as required for the circuits shown:
      a. Representative one-line diagram, legends and types of protective devices selected.
      b. Power company's relays or fuse characteristics.
      c. Significant motor starting characteristics.
      d. Parameters of transformers, ANSI magnetizing inrush and withstand curves.
      e. Operating bands of low voltage circuit breaker trip curves, and fuse curves.
      f. Relay taps, time dial and instantaneous trip settings.
      g. Cable damage curves.

h. Symmetrical and asymmetrical fault currents.

6. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. A tabulation of the recommended power fuse selection shall be provided for all fuses in the system.

E. Arc Flash Study

1. An arc flash study shall be performed to identify the parameters of the zone of protection, and label the Switchgear as per IEEE 1584 requirements.
2. Arc Flash study report shall contain the following information:
    - Bus name
    - Protective device name
    - Bus kV
    - Bus bolted fault level (kA)
    - Bus arcing fault level (kA)
    - Protective device bolted fault level (kA)
    - Protective device arcing fault level (kA)
    - Trip/Delay time (sec)
    - Breaker opening time (sec)
    - Ground
    - Equipment type
    - Gap (mm)
    - Arc flash boundary (mm)
    - Working distance (mm)
    - Incident energy (j/cm^2)
    - PPE Level
    - Proposed label
    - Cable length from trip device
    - Incident energy at low marginal
    - Incident energy at high marginal
3. Contractor shall furnish and install all Arc flash study labels and affix to the respective switchgear.

2.2 STUDY REPORT

A. The results of the power system study shall be summarized in a final typewritten report. The report shall include the following Sections:
1. Description, purpose, basis, written scope, and a single-line diagram of the power distribution system which is included within the scope of the study.
2. Tabulations of circuit breaker, fuses, and other equipment ratings versus calculated short-circuit duties, and commentary regarding same.

3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
4. Fault current tabulation including a definition of terms and a guide for interpretation.
5. Tabulation of appropriate tap settings for relay seal-in units.

PART 3 - EXECUTION

3.1 FIELD TESTING

A. The Contractor shall provide field testing of the distribution system. All field testing shall be performed by the testing firm, after the completion and approval of the power system studies. The field testing shall be witnessed by the Engineer and certified by the Contractor.

B. The testing firm shall adjust, set, calibrate and test all protective devices. All protective relays and meters in the medium and low voltage equipment shall be set, adjusted, calibrated and tested in accordance with the manufacturer's recommendations, the coordination study and best industry practice.C. Proper operation of all equipment associated with the device under test and its compartment, shall be verified, as well as complete resistance, continuity and polarity tests of power, protective and metering circuits. Any minor adjustments, repairs and/or lubrication necessary to achieve proper operation shall be considered part of this Contract.

D. All solid state trip devices shall be checked and tested for setting and operation. Circuit breakers and/or contactors associated with the trip devices shall be tested for trip and close function with their protective device.

E. All tests shall be in accordance with the manufacturer's recommendations and NETA, ATS Acceptance Testing Specification.

F. The Contractor shall provide a field testing report. The report shall be in accordance with NETA, ATS Acceptance Testing Specification.

3.2 MAINTENANCE OF OPERATIONS

A. Since the field testing work specified shall require that certain pieces of equipment be taken out of service, the Contractor shall perform the work with due regard to maintenance of operations and construction staging in accordance with the Specifications. All testing procedures and schedules must be scheduled in advance prior to any work beginning.

+ + END OF SECTION + +

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SECTION 16293

MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR

PART 1 GENERAL

1.1 SECTION INCLUDES

A. The Contractor shall furnish, install, test and place into satisfactory operation medium voltage metal-clad switchgear as shown on the Contract Drawings and specified herein.

1.2 RELATED SPECIFICATIONS

A. Specification 16036 - Testing

B. Specification 16076 - Labeling and Identification

C. Specification 16292 - Power Distribution System Coordination

D. Specification 16911 - Electrical Monitoring and Control System

1.3 REFERENCES

A. ANSI C37.20.2 Metal-Clad and Station Type Cubicle Switchgear.

B. NEMA SG-4 Standards for Power Circuit Breakers.

C. NEMA SG-5 Power Switchgear Assemblies.

D. ANSI C57.13 Requirements for Instrument Transformers

E. ANSI/IEEE C39.90.1 - Surge Withstand Capability Test

F. NFPA 70 – National Electric Code

1.4 SYSTEM DESCRIPTION

A. The system shall consist of the following equipment, as minimum:

1. Draw-out vacuum, electrically operated circuit breakers.
2. Instrument transformers.
3. Protective relays.
4. Metering, monitoring and communication equipment.

5. Battery control system.

6. Mimic panels.

7. Annunciator panels.

1.5 DESIGN REQUIREMENTS

A. The Contractor shall provide fully functional medium voltage metal-clad switchgear assemblies as shown on the Contract Drawings and specified herein.

B. The Contractor shall provide all necessary wiring, contacts, terminal blocks, protective relays, switches, etc. as required for proper operation, whether shown or not.

C. The Contractor shall coordinate the relay and circuit breaker settings with the independent testing firm, which is required and described in Specification 16292 - Power Distribution System Coordination.

D. The metal-clad switchgear shall have electronic metering, monitoring and communications as described in this section and Specifications 16911 - Electrical Monitoring System.

E. All identical switchgear compartments shall be wired the same.

F. The Contractor shall synch all relays within the total electrical system to the same clock to ensure every relay shows the same time of day and date.

1.6 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings.

1. Certified dimensioned outline drawings showing equipment layouts, front view and floor plan in sufficient detail to define space required for dismantling

and maintenance, exact location of and space available for conduit entrance and the interrelationship of the various components.

2. Cross sections and details, as required, to satisfy the Engineer, that all components conform to specification requirements, including design and physical arrangement. All information required by the Engineer for the design and location of all connecting structural, mechanical, or electrical items such as piping, ducts, cables, conduit, etc.

3. Weight of the equipment and distribution on the foundation support of the static, impact, wind, and other loads.

4. Erection drawings.

5. Elementary Diagrams and Interconnecting Wiring Diagrams having their terminals identified and indicating the internal wiring and all control and test switch developments. Common Elementary and Interconnection Wiring Diagrams shall not be acceptable. Separate drawings for each equipment shall be supplied. Wire lists in lieu of wiring diagrams shall not be acceptable. Separate drawings for each compartment shall be supplied including individual compartment point-to-point wiring diagrams.

6. Complete three-line diagrams detailing connections for all instrument transformers, relays, meters, etc.

7. Complete Bill of Material.

8. Details of special features.

9. Manufacturer published time-current curves (on full logarithmic paper) and instruction manuals of all protective relays for the equipment.

10. Current and potential transformer data, curves, and burden calculations for each CT and PT circuit.

11. Nameplate schedules.

12. Recommended spare parts list with pricing.

14. List of Special Tools.

15. Painting Procedures.

16. List of recommended lubricants.

17. Preliminary Operation and Maintenance manuals.

C. Certificates of Compliance/Manufacture.

1. Provide letter stating qualifications of manufacturer as specified in paragraph 1.7.

D. Reports.

1. All shop test and field test reports.
2. All manufacturer's site visit reports.

1.7 QUALITY ASSURANCE AND QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.8 SPARE PARTS, TOOLS AND SUPPLIES

A. The Contractor shall furnish all spare parts in conformance with Division 1. Deliver all spare parts, tools and supplies with the equipment, neatly wrapped or boxed, indexed and tagged with complete information for use and reordering.

B. Furnish the following spare parts:

1. Furnish all spare parts as recommended by the manufacturer.
2. Furnish one (1) spare protective relay for each type installed.
3. Furnish one (1) spare set of CT's for all sizes installed
4. Furnish one (1) spare 5kV 1200A frame vacuum circuit breaker.
5. Furnish 10% of indicating lights installed on the switchgear.

C. Furnish the following tools:

1. One (1) Maintenance Tool for manually charging the breaker closing spring and manually opening the shutter.

2. One (1) Levering Crank for moving the breaker between test and connected positions.

3. One (1) Test Jumper for electrically operating the breaker while out of its compartment.

4. One (1) Breaker Lifting Yoke used for attachment to breaker for lifting breaker on or off compartment rails.

5. One (1) Set of rail extensions and rail clamps.

6. One (1) Portable lifting device for lifting the breaker on or off the rails.

7. One (1) Ramp for rolling breaker mounted in lower compartment directly onto the floor.

8. One (2) Test cabinet for testing electrically operated breakers outside housing.

9. One (1) "Dockable" transport dolly for moving breaker about outside its compartment.

10. One (1) Electrical levering device.

D. Lubricants

1. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the equipment furnished under this section for a period of one (1) year after acceptance. Replace all lubricants used during startup and testing prior to acceptance of equipment. Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers of the metal-clad switchgear shall be as follows:

1. ABB

2. Eaton

3. Square-D

2.2 MATERIALS

A. Metal-clad switchgear assemblies shall be comprised of vertical sections mechanically and electrically connected to form a complete switching equipment unit. The switchgear assembly shall be suitable for either bolting or welding to floor sills. The assembly shall be designed to prevent entry of vermin.

B. The switchgear assembly shall be suitable for lifting by crane and also for moving by use of jacks and rollers. The switchgear assembly shall include the number of vertical sections and be arranged as shown on the Contract Drawings.

C. Structural or formed steel lifting beams for lifting any shipping section of the switchgear shall be supplied by the Contractor. These beams shall be sufficiently rigid to distribute evenly all strains which may be imposed in handling.

D. The switchgear steel frame assembly shall be provided with station ground-connection points at each end section by means of ground pads or other acceptable means to the Engineer.

E. The switchgear shall be designed, constructed and installed suitable for earthquake regulation in accordance with the seismic requirements of the State of New York Building Code and the Uniform Building Code.

2.3 STRUCTURE

A. Each vertical section shall be a self-supporting structure consisting of a bolted or welded steel frame with reinforcing gussets. Front and rear doors, top and side covers shall be assembled on this frame. The external covers and doors shall be 11-gauge steel minimum. Each section shall consist of one or two compartments arranged vertically. Each compartment shall contain a draw-out breaker or draw-out potential and control power transformer.

B. One front and one rear door shall be mounted on each vertical compartment. Each door shall be provided with a full-length hinge, door stop, hex-knob closing screws and provisions for padlocking shall be provided. The control, instrumentation, and protection devices associated with the breaker in the compartment shall be mounted on the front compartment door of the same breaker. Terminal blocks, fuse blocks, and some control devices may be mounted inside the enclosure on the side panels.

C. When it is not possible to install all the equipment shown on the one line diagram in one breaker unit housing, an auxiliary unit shall be furnished. The auxiliary unit shall have no provision for accepting a circuit breaker and shall be used to house equipment

such as potential transformers, surge arresters, control power transformers, etc., as required.

D. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell. The shutters shall be labeled "LINE" and "LOAD" respectively. Provide rails to allow withdrawal of 5kV circuit breaker for inspection and maintenance without the use of a separate lifting device.

2.4 BUS

A. The main bus shall be copper and have fluidized bed epoxy flame retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, glass polyester for 5-kV class. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. A set of insulated copper main bus, sized as shown on the Contract Drawings, shall be provided and have provisions for future extension. All bus joints shall be silver plated, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests. Bus phase rotation shall be A-B-C.

B. A copper ground bus shall extend the entire length of the switchgear and shall be bolted to each vertical section and to each breaker ground contact. The ground bus shall be extended into each primary cable compartment for convenient field connection of cable shields. Switchgear shall be equipped with external grounding studs.

C. An insulated, fully rated neutral bus shall extend the entire length of the switchgear, whenever a neutral bus is shown on the Contract Drawings.

D. Bus phasing shall be identified A, B, and C from top to bottom, front to back, and left to right, as viewed from the front of the equipment.

E. Bus rating current density shall not be greater than 1000 amps per square inch.

2.05 WIRING AND TERMINATIONS

A. All auxiliary switches shall be field reversible. All secondary circuit wiring, including annunciator supervisory circuits, shall not be smaller than No. 12 AWG. PT circuit wiring shall not be smaller than No. 12 AWG and CT circuit wiring shall not be smaller than No. 10 AWG. The control wire shall be flexible, stranded, tinned-copper, Type SIS, 600V rated.

B. Wiring shall be neatly arranged and clamped securely to panels to prevent movement and breaking. Wiring clamps and supports at hinge transition points shall be properly sized to prevent chafing of insulation when the cubicle door is opened or closed. Metal clamps must have insulating inserts between the clamps and wiring. Connection of cables, supports and cable harnesses to panels with adhesive shall not be acceptable.

C. Connections between shipping sections shall be arranged to require a minimum of field wiring. Terminal blocks shall be provided on one side of a shipping break and coiled wires, properly tagged, shall be provided on the other side to facilitate these connections.

D. All secondary leads of each current transformer shall be wired directly to shorting type terminal blocks. Delta or Wye connections shall be made using jumpers on the load side of terminal block.

E. Terminal blocks shall be barrier type, with a marker strip down the center and shall be suitable for locking spade type terminal lugs. They shall be located a minimum of 10 in. from the base of the unit. Each terminal shall be numbered or marked in a clear, easy-to-read manner with labels which refer to the designations used on wiring diagrams. Parallel rows of terminal blocks shall be spaced a minimum of 5 in. on center. Twenty percent spare terminals shall be supplied by the Contractor.

F. Instrument transformer circuit grounds shall be made independently to the ground bus through a terminal block that is used for Purchaser's connections. Only one ground connection shall be provided for each circuit.

G. Control wire including space heater AC power bus, P.T. leads, and C.T. leads shall be terminated using locking spade type lugs. Wire splices and ring type wire lugs will not be accepted.

H. Spare breakers shall have complete wiring the same as defined for fully equipped spaces.

I. Each space heater circuit shall be fused from the 120 volt ac power bus and shall be wired through the breaker auxiliary switch. Heater circuits shall be energized when the breaker is open or is removed from operating position.

J. All 600V wiring in the high voltage sections shall be the shielded type.

2.6 CIRCUIT BREAKER AND AUXILIARY COMPARTMENTS

A. The circuit breaker compartment shall house a drawout circuit breaker element and include primary and secondary disconnecting contacts. Grounded safety shutters shall automatically cover stationary contacts when the breaker element is withdrawn from the connected position. The draw-out type assembly shall be provided with a mechanical interlock to prevent moving the breaker into or out of the operating position unless the breaker is open.

B. The cable compartment shall be at the rear of the breaker compartment. The compartment shall have ample space for cables, stress cones, potheads, current transformers and other related components. Barriers shall be provided to isolate circuit terminations when there are two breakers in the same vertical section. Top or bottom conduit entries shall be provided as indicated on the Contract drawings. Connectors for terminations shall be furnished by the Contractor.

C. Where shown on the Contract Drawings the compartment shall be suitable for terminating non-segregated phase bus duct.

D. Current transformers shall be located over the primary insulating tubes in the breaker compartment. They shall be accessible from the front to permit changing transformers when the unit is deenergized.

E. Bus differential current transformers shall be provided as shown on the One Line Diagram. Bus differential current transformer shall be installed so that its opening is clear for easy installation of field cables. Field drilling of holes in supports is not acceptable.

F. The auxiliary compartment shall be used to mount potential transformers with fuses, surge arresters, control power transformers, etc. Where rollout trays are provided to mount potential or control power transformers, the movable carriage shall be equipped with primary and secondary disconnecting devices, grounding devices and a safety barrier. Auxiliary compartments shall be furnished when all auxiliary equipment cannot be accommodated in the breaker unit.

G. Circuit breaker and auxiliary compartments shall be equipped with space heaters, where shown on the Contract Drawings.

2.7 CIRCUIT BREAKERS

A. The circuit breakers shall have removable vacuum circuit breaker elements with the following ratings:

5kV

1.	Maximum Voltage	5kV
2.	BIL Rated	60kV
3.	Continuous Current	2000A
4.	Short Circuit RMS @Rated Maximum Voltage	25kA RMS
5.	Closing and Latching Capability	77 kA Crest
6.	Three Second Rating	48kA RMS
7.	Nominal 3-Phase MVA	Class 1000
8.	Rated Interrupting Time	5 Cycles

B. All breakers of the same rating shall be interchangeable and fit any breaker compartment of the same rating. Compartments shall be interlocked to prevent insertion of the lower rated breakers.

C. The breakers shall be electrically operated by a motor-charged, spring-type stored energy mechanism. After the circuit breaker is closed, the motor shall charge the closing springs for subsequent operation of the breaker. The electric motor shall be rated at 125 VDC and shall operate from 90 to 140 VDC.

D. Each circuit breaker shall be furnished with mechanical indicators for:

1. Positive indication of breaker open or closed position
2. Breaker closing spring charged or discharged position
3. Positive indication of breaker position, i.e. connected test, or disconnect

E. The stored energy closing springs shall be suitable for manual as well as electrical charging, and a front-operated manual spring charging handle shall be furnished for manual charging.

F. Trip and close levers for manual operation shall be furnished on the circuit breaker element.

G. When the circuit breaker is in the test position, control circuits shall permit local operation of the breaker.

H. Circuits for remote operation of the breaker shall be disconnected when the breaker is in the test or disconnect position.

I. Circuits used for energizing space heaters and for interlocking with other electrically operated circuit breakers and wired through "b" auxiliary contacts shall be maintained automatically in the disconnect position of the circuit breaker.

J. Breakers shall be mechanically and electrically trip-free in all positions.

K. Circuit breakers shall be equipped with an anti-pumping feature.

L. Grounding of the circuit breaker base shall be automatically applied before primary contacts are made and shall be maintained until the primary contacts have been separated by a safe distance.

M. A suitable mechanism for manually inserting and withdrawing the removable element shall be provided for each circuit breaker. The mechanical advantage ratio shall be such that the device may be operated easily by one man.

N. The breaker shall have provision for padlocking in the test and disconnect positions. When padlocked in the disconnect position the breaker element shall be locked in the compartment.

O. Mechanical interlocks shall be provided to positively prevent the circuit breaker from being racked in or out unless the breaker is open. This interlock shall also prevent closing the breaker by any means while it is being racked in or out.

P. Each breaker shall be complete with control switch and red, amber, and green indicating lights to indicate breaker position and that it has been tripped. Indicating lights shall be the LED type. Maximum mounting height of breaker control switches shall be 6'-6" above the bottom of the switchgear structure.

2.8 PROTECTIVE RELAYS

A. General

1. The switchgear manufacturer shall furnish and install, in the metal-clad switchgear, the quantity, type and rating of protection relays as indicated on the Contract Drawings and specified herein.

2. Alternating-current instruments and relays shall be suitable for operation from 5 amp current and 120V potential circuits at 60 Hz. They shall not be injuriously affected by primary short circuit current rating of the assembly. All instruments and relays shall be accurately adjusted and calibrated before shipment. The arrangement of equipment on the front of the switchgear panel shall be subject to approval by the Engineer.

3. Protective relays shall be equipped with semi-flush mounted cases, totally withdrawable, with integral test facilities and automatic current transformer shorting with sequenced disconnect, and conform to ANSI C37.90. Static relays shall be qualified for surge withstand capability (SWC) in conformance with ANSI C37.90.

4. Control relays shall be designed to relieve control and auxiliary switches of interrupting currents above their rating. The control equipment shall be such that a maintaining contact may be used if desired. Two spare control relays with 125VDC coil and four normally open and four normally closed contacts shall be completely wired to terminal blocks.

5. Alarm relays shall be installed to monitor 125 VDC power supply to circuit breaker control circuit, to provide input to remote alarm should the power supply fail.

6. Instrument and relay phasing shall be left to right or top to bottom with neutral relays underneath phase grouping.

7. Where possible, relays shall be mounted above the control switch on their respective panels. Relays shall be located as close to the switches as possible and shall be placed at a height convenient for adjustment by a worker standing on the floor.

8. The manufacturer shall furnish and install all contacts, relays, switches, etc. required for proper operation, per the Contract Drawings, Specifications and as required.

9. Lead seals shall be installed for all relays after relay has been installed and programmed.

B. Microprocessor Three-Phase Protective Relay

1. Relays for phase time over-current, instantaneous overcurrent and ground fault protection, ANSI 50/51, 50/51G, or 50/51N, shall be incorporated into a single device.

2. The relay shall be solid-state microprocessor-based multifunctional type that operates from the 5-ampere secondary output of current transformers. The

relay shall provide ANSI 50/51N protective functions for each of the three (3) phases, and ANSI 50/51N or 50/51G ground fault protection functions as shown on the Contract Drawings or as determined by the coordination study. The relay shall be true RMS sensing of each phase and ground. Ground element shall be capable of being utilized in residual, zero sequence, or ground source connection schemes, or deactivated.

3. The primary current transformer rating being used for phase and ground protection feeding the device shall be programmable for current transformers with primary current ratings from 5 through 5,000 amperes.

4. Both the phase and ground protection curves shall be independently field selectable and programmable with or without load. Curves shall be selectable from the following:

    a. IEEE:Moderately inverse, very inverse, extremely inverse

    b. IEC:A, B, C, or D

    c. Thermal:Flat, It, I^2t, I^4t

5. Thermal curves shall be similar to those on low-voltage trip units for close coordination with downstream devices. Selectable short delay pick-up and short delay time settings shall also be provided. The phase instantaneous over-current trip shall have field programmable pick-up points from 1.0 to 25 times current transformer primary rating or NONE. In addition, a field selectable (ON or OFF) discriminator circuit shall be included such that when phase instantaneous overcurrent has been programmed to NONE, the discriminator circuit shall protect against currents exceeding 11 times current transformer primary rating, only when the breaker is closed.

6. The relay shall be field configurable to have either of the following function combinations assigned to its' two type "a" contacts: 1) one contact assigned ANSI 51 phase and ANSI 51 ground and the other contact assigned ANSI 50 phase and ANSI 50 ground; 2) one contact assigned ANSI 51/50 phase and the other contact assigned 51/50 ground.

7. The relay shall have a built-in alphanumeric display capable of displaying the following information with metering accuracy of ± one (1) percent of full scale (I_n) from 0.04 x I_n to 1 x I_n and ± two (2) percent of full scale (I_n) from 1 x I_n to 2 x I_n:

    a. Individual phase currents.

    b. Ground current.

    c. Cause of trip.

d. Magnitude and phase of current causing trip.

e. Peak current demand for each phase and ground since last reset.

f. Current transformer primary rating.

g. Programmed phase and ground set-points.

8. The relay shall have the following features:

a. Integral manual testing capability for both phase and ground.

b. A full bus differential scheme shall be required for both phase and ground in addition to specified time overcurrent and instantaneous overcurrent phase and ground fault protection. Bus differential scheme shall be provided with separate differential current transformers for all incoming and out-going loads, as well as appropriate differential relays (ANSI 87 and 87G) as approved by the Engineer.

c. Continuous self-testing of internal circuitry.

d. Unit failure alarm contact for customer use.

e. Programmable lockout/self reset after trip function.

f. Programmable set-points for device curve selection.

g. Programmable inputs, such as current transformer ratios.

h. Access to program and test modes shall be via sealable hinged cover for security.

9. The relay shall be suitable for operating temperatures from 30 degrees to 55 degrees C. Relay shall be suitable for operating with humidity from 0 to 95% relative humidity (noncondensing).

10. The relay shall have the communication capability via local area network compatible to the electrical monitoring system. Relay shall be capable of the following over the communication network:

a. Ability to transmit all information contained in the relay such as currents, set-points, cause of trip, magnitude of trip current, and open-close trip status.

b. Ability to close and open the associated breaker with proper access code from remote location over the communication network when the relay is dip switch configured in remote close/open mode.

11. Relay alarm and/or trip contacts shall not change state if power is lost or an under-voltage occurs. These contacts shall only cause a trip upon detection of an over-current or fault condition based upon programmed settings.

12. The relay shall be suitable for operating on control power with a nominal input voltage of 125 volts DC.

C. Lockout Relays

1. Lockout relays (Device 86) shall be heavy-duty, multi-contact type with pistol grip handle control switch.

2. The mechanical target on the escutcheon plate assembly shall indicate relay position.

3. Reset position shall be indicated by a black target and tripped indication shall be by an orange target.

4. Coil voltage shall be 125 VDC.

D. Feeder Management Relays

1. The feeder management relays shall provide primary protection and management of distribution feeders. Protection shall include:

a. Complete time overcurrent.

b. Complete instantaneous overcurrent.

c. Directional overcurrent.

d. Undervoltage and overvoltage.

e. Negative sequence voltage.

f. Undervoltage automatic restoration.

g. Bus underfrequency.

h. Underfrequency automatic restoration.

2. Control shall include manual close controls, cold load pick-up control, four (4) settings groups, 20 programmable logic inputs, two (2) breaker control relay outputs, one (1) internal failure relay output, five (5) programmable relay outputs, one (1) solid state trip output, and eight (8) analog transducer outputs.

3. The relay shall provide complete monitoring and metering functions. These shall include:

    a. A fault locator with a record of the last 10 faults.

    b. An event recorder with a record of the last 128 events.

    c. Waveform capture with storage of 128 cycles of data.

4. A power simulation feature shall be included to allow testing without the need for external voltage and current inputs. User interfaces shall include:

    a. A 40-character display and a keypad.

    b. Indicator LEDs on the front panel which shall provide a quick visual indication of status.

    c. A front panel RS232 serial port which shall provide easy computer access.

    d. Two (2) rear RS485 ports, one of which can be configured as a RS422 port.

    e. An easy to use PC program.

5. Feeder management relays shall be equal to GE MULTILIN,Type 850.

E. Transformer Management Relays

1. Protection for small, medium, and large power transformers shall be provided by a high speed multi-processor based relay.

2. The following protection functions shall be included:

    a. Three phase differential current relays with dual slope percentage differential restraint and harmonic restraint.

    b. Unrestrained differential overcurrent.

    c. Two (2) instantaneous overcurrent elements for each phase winding, calculated neutral, and ground current.

    d. One time overcurrent element for each phase winding, calculated neutral, and ground current.

    e. Negative sequence overcurrent.

f. Underfrequency and rate-of-change elements for load shedding.

g. Overfrequency element.

h. Overexcitation to protect against overvoltage and overfluxing.

3. Enhanced flexibility of the protection system shall be provided by the following:

a. Auto-configuration of transformer CTs to wye configuration.

b. Programmable protection logic using FlexLogic™ to allow any combination of protection elements, logic inputs, and timers to be assigned to any output.

c. Adaptive harmonic restraint to prevent false tripping during inrush offers three (3) programmable restraint methods.

d. Multiple setpoint groups.

e. Dynamic CT ratio mismatch correction.

f. Adaptive time overcurrent curves which take into account the transformer capability when supplying nonsinusoidal load currents.

4. Metering and monitoring shall include:

a. Metering of currents, running and maximum current demand.

b. Oscillography data sampled at 64 times per power cycle.

c. Simulation mode for testing.

d. Harmonic level detectors.

e. Event recorder for up to the last 128 events.

f. Tap position, ambient temperature.

g. Analog transducer input (optional).

5. The following inputs and outputs shall be provided:

a. 16 logical inputs.

b. One (1) analog input (optional).

c. One (1) high speed electronic output.

d. Eight (8) electro-mechanical relay outputs.

e. Seven (7) analog output channels (optional).

f. An IRIG-B input.

6. FlexLogic™ shall be provided to define configurable outputs.

7. The user interface shall include a 40 character display and a keypad with control keys and a full numerical keypad. Twenty-four (24) LED indicators shall be provided to indicate relay status, system status, and trip or alarm conditions.

8. Remote communications shall be provided via two (2) RS485 ports, one of which can be configured as a RS422 port. ModBus® RTU/DNP 3.0 Level 2 protocol shall be used, and data transmission rates of up to 19,200 bps shall be supported. A front panel RS232 communications port shall be provided for local PC access. Software shall be provided with the relay.

9. The relay shall consist of a drawout unit and a companion case. The case shall have a front door with a large window.

10. Transformer management relays shall be equal to GE Multilin, Type 845.

F. Individual Protective Relays.

1. Relays for specific protective functions where shown on the Contract Drawings, which are not incorporated in the relays described in paragraphs D, E and F above, shall have the following features:

a) Microprocessor based control functions.

b) Front mounted potentiometers, settings for pick-up and drop-out values, timing values, etc.

c) 125 VDC control voltage.

d) Output contacts.

e) Target indicators.

f) Push-to-energize output switches for testing purposes.

g) Surge withstand capability per ANSI/IEEE C39.90.1-1989, Surge Withstand Capability Test.

G. Relay Manufacturers

1. The time and instantaneous over-current, and ground fault relays (Devices 50/51) shall be manufactured by the circuit breaker manufacturer. The relays communicate with the circuit breakers and the electrical monitoring system and therefore must be compatible with those systems.

2. Individual protective relays shall be equal to the "BE1 Protective Devices" as manufactured by Basler Electric and GE MULTILIN Electronic Relays.

3. The lockout relays shall be equal to "HSA Multi-Contact Hand Reset Auxiliary Relays" as manufactured by the General Electric Co.

4. The feeder management, generator management and transformer management relays shall be equal to GE MULTILIN, Types 850, 889 and 845, respectively.

I. Relay Test Kits

1. Furnish test kits to allow relay testing without removing system wiring. Provide a test kit for each relay type, if different test kits are required. Otherwise, one test kit for any group or number of relays is acceptable.

H. Relay Setting

1. All relays shall be set based on the short circuit and relay coordination study, as described in Section 16292 - Power Distribution System Coordination.

2.9 INSTRUMENT TRANSFORMERS

A. Current and voltage transformers shall be furnished for the switchgear relays, breakers, meters and transducers, and for converting bus voltage to appropriate control voltages. There shall be two (2) separate sets of transformers for each circuit breaker circuit. One set shall be used exclusively for relaying circuits and the other set shall be used exclusively for metering circuits.

B. The current and voltage transformers shall have the following accuracy classes:

Current Transformer Ratio	Minimum Accuracy Class
Up to 400/5	T100 or C100
500/5 to 800/5	T200 or C200
900/5 to 1200/5	T400 or C400
2000/5 and higher	T800 or C800

Voltage kV Operating	Voltage kV Rated	Min. Accuracy Class	XFMR BIL kV	Ratio
4.16	5.0	1.2Z	60	35:1

C. Ring type current transformers shall be furnished as indicated on the Contract Drawings. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. The standard location for the current transformers on the bus side and line side of the 15kV breaker units shall be front accessible to permit adding or changing current transformers without removing high-voltage insulation connections. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.

D. Voltage and control power transformers of the quantity and ratings shall be supplied as indicated on the Contract Drawings and as required. Voltage transformers shall be mounted in drawout drawers contained in an enclosed auxiliary compartment. Control power transformers up to 15 kV, 15 kVA, single-phase shall be mounted in drawout drawers. Rails shall be provided for each drawer to permit easy inspection, testing and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn.

E. A mechanical interlock shall be provided to require the secondary breaker to be open before the CPT drawer or CPT primary fuse drawer can be withdrawn.

2.10 METERING, MONITORING AND COMMUNICATIONS

A. Provide customer metering devices where shown on the Contract Drawings. Where indicated provide a separate customer metering compartment with front hinged doors. Include associated instrument transformers.

B. Provide current transformers for each meter. Current transformers shall be wired to shorting type terminal blocks.

C. Provide potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the Contract Drawings.

D. Paragraph 2.08.B - Microprocessor Three-Phase Protective Relay, discusses the circuit breaker trip unit which, in addition to protective features, has metering and communication capabilities with the electrical monitoring system.

E. Meter Analyzer and Protection Devices

1. Where indicated on the Contract Drawings, provide a digital line Meter Analyzer and Protection (MA&P) device having the features and functions specified below. The MA&P shall be UL listed, CSA certified and also meet ANSI Standard C37.90.1 for surge protection.

2. The MA&P shall provide direct reading metered or calculated values of the items listed below and shall auto range between Units, Kilo-units and Mega-units for all metered values. The device shall be capable of displaying multiple parameters at once, including two (2) user configurable custom screens displaying any seven (7) of the parameters listed. Indicator LED shall always

remain active to display device status for safety and trouble-shooting purposes. Time, date, software version, and network address shall also be displayed. Accuracy indicated below to be of read or calculated values based on full scale.

a. AC Current (Amperes) in A, B, and C phase, 3Phase Average, Neutral (N) and Ground (G). Accuracy ± 0.2%.

b. AC Voltage (Volts) for A-B, B-C, and C-A, Phase Average, A-N, B-N and C-N, Average Phase to N, and N to G. Accuracy ± 0.2%.

c. Real Power (WATTS), Reactive Power (VARS), Apparent Power (VA), for each phase and system. Accuracy ± 0.4%. Forward/Reverse indication shall be provided.

d. Real Energy (WH), Reactive Energy (VARH), Apparent Energy (VAH) for each phase and system. Accuracy ± 0.4%. Forward/Reverse indication shall be provided.

e. Frequency (HERTZ) Accuracy ± 0.4%.

f. Demand values for System Current (AMPERES), System Real Power (WATTS), System Reactive Power (VARS), and System Apparent Power (VA).

g. Power Factor for both Displacement only 60-cycle fundamental WATTS to VA and Apparent total WATTS to total VARS including harmonics for A, B, and C phase and system. Accuracy ± 0.8%.

h. Current Percent Total Harmonic Distortion (THD), in A, B, and C phase and N.

i. Voltage percent THD in A-B, B-C, and C-A phase, A-N, B-N and C-N.

j. K-Factor (sum of the squares of harmonic currents times the square of their harmonic numbers).

k. Transformer Derating Factor (1.414 divided by the Crest Factor).

l. Crest Factor (ratio of peak current to RMS current).

3. The MA&P shall provide the following advanced analysis features:

a. Trend Analysis Screens displaying the minimum and maximum values for each metered value, with all parameters time stamped to 1-second resolution.

b. Demand Analysis screens displaying present demand and peak demands for current (phase A, B, C, N, and G) and power (system real (kW), reactive (kVAR), and apparent (kVA)). Peak demands shall display time and date stamped to within 1-second resolution. Demand Window Selection for metered demand values shall be selectable either as:

1) A user selectable fixed window (programmable from 1 to 60 minutes).

2) Sliding window method with programmable 1 to 60 minute subintervals, for power (kW, kVAR, kVA) demand only.

3) Initiated from a synch pulse for power (kW, kVAR, kVA) demand only.

4) Communication signal initiated from an electrical monitoring system network master computer.

a. Harmonic Analysis Screens shall be capable of being function key triggered to capture a high-speed wave form of two (2) cycles of data sampled at 128 samples per cycle, simultaneously recording current in A, B, and C phases, N, and G as well as all voltages A-B, B-C, and C-A phases, A-N, B-N, CN, and N-G. Data captured shall include the magnitude (% of the fundamental) and the direction of harmonic source (phase angle) for all odd and even multiples of fundamentals from 1st through the 50th.

b. Event/Alarm Analysis Screens shall display data recorded for up to ten (10) event/alarm conditions. The initiation level of the declaration of an event/alarm condition shall be field programmable for all measured parameters. For each event/alarm a description of the event/alarm, date, and time of event/alarm shall be recorded (10 ms resolution). In addition, a capture shall be made of all metered values available and all current and voltage distortion information available on the Harmonic Analysis Screens.

c. The MA&P shall be capable of transmitting all data at time of the event via communications to a personal computer for creating and displaying wave forms. In addition, the

Event/Alarm Analysis Screens shall be capable of being initiated from an energized discrete input circuit, or through the communications port.

d. Event/Alarm Condition Levels shall be capable of being triggered by up to 7 of any of 61 conditions when the programmed threshold is exceeded. All shall have programmable time delays from 0.1 to 60 seconds except voltage disturbance which shall be programmable from 0 to 3600 cycles.

Condition	Voltage Disturbances
1	Undervoltage/sag--A-B, B-C, A-C (selectable from 50 to 100%)
2	Undervoltage/sag--A-N, B-N, C-N (selectable from 50 to 100%)

Condition
Minimum or Maximum Threshold Exceeded

3 Overvoltage/swell--A-B, B-C, A-C (selectable from 100 to 150%)
4 Overvoltage/swell--A-N, B-N, C-N (selectable from 100 to 150%) If time delay is programmed, any disturbance lasting two (2) cycles (less if magnitude is sufficient to effect RMS readings) shall trigger voltage disturbance event/alarm.

Maximum Threshold Exceeded

5-24 Present THD (2-1000) or Magnitude of THD for:

- Current Phases A, B, C
- Voltage A-B, B-C, C-A
- Voltage A-N, B-N, C-N

25-31 Demand

- Current Phases A, B, C, Average
- System Power-watts, vars, VA

32 Voltage -- Neutral to Ground

33-34 Current -- Neutral or Ground

33-40 Current Phases A, B, C

41-46 System Power - watts, vars, VA

47-49 Frequency High, Low, High or Low

50-53 System Power Factor

- Displacement Minimum and Maximum

- Apparent Minimum and Maximum

Voltage Phase Unbalance

54-55 Voltage Line-to-Line or Line-to-Neutral

Current Phase Unbalance

56 Current comparison between Phases A, B, C

Discrete Input Energized

57-59 Input 1, 2, 3

Electrical Monitoring System Communication

60 Remote command through communications port

Manual Capture

61 Manual capture from pushbutton at device.

4. The MA&P shall be capable of receiving the following inputs:

a. Instrument transformers: Input ranges of the MA&P shall accommodate external current transformers with ranges from 10,000/5 through 5/5 amperes. Provide external current transformers for each phase, neutral and ground circuit with rating as indicated on the Contract Drawings or sized for incoming service or associated feeder. MA&P shall be capable of overranging up to eight (8) times nominal current rating. Potential transformers shall be self-included and fused for up to 600 volts with potential connections suitable for 3-phase, 120-volt, 208/220/240-volt, 380/416-volt, 460/575-volt. Above 600 volts, provide fused external potential transformers for up to 500 kV.

b. Control Power: The MA&P control power shall be capable of being supplied form the monitored incoming AC line up to 600 volts without the need for a separate AC control circuit unless a separate 120or 240-volt source is indicated on the Contract Drawings. The device shall also be capable of being supplied form

a separate control power source when indicated on the Contract Drawings (input range of 96 to 264 volts AC or 100 to 350 volts DC).

c. Dry Contacts: Three (3) dry discrete input contacts shall be capable of being monitored which may be programmed by the user to perform any of the following functions. The status of the input contacts shall be locally displayable and accessible through the communications port.

5. Trigger an Event/Alarm Analysis including Harmonic Analysis information for display on the device and information for Wave Form Analysis and display at a personal computer.

6. Act as a synchronizing pulse input to synchronize demand windows with a utility provided synchronizing pulse.

7. Actuate a relay output.

8. Reset a relay output, peak demand, Minimum/Maximum, or Event Analysis records.

9. Furnish Relay Output Contacts with four (4) Form C (NO/NC) relay output contacts which shall be capable of being independently programmed for the following functions:

a. Act as a kWH, kVARH, or kVAH pulse initiator output.

b. Actuate on one (1) or more Event/Alarm conditions, including discrete inputs and Communication Command signal. Each relay contact shall be capable of being set for Auto or Manual Reset with 0- to 30minute release delay in one second increments. Relay contacts programmed to actuate on undervoltage shall also have a programmable 0- to 30-minute delay on power-up for transfer applications.

10. Furnish one (1) 0 to 20 mA analog input and three (3) 0 to 20 mA outputs. The input values shall be capable of being displayed on the device as a percentage and shall also be accessible throughout the communications port. Each analog output shall be programmable to reflect a phase current, voltage, power, demand, % THD, power factor, or system frequency.

11. The device shall be fully programmable from the faceplate, including alarm relay and power quality (e.g., harmonic distortion) settings. Programming shall be password protected.

12. Provide an addressable communication card capable of transmitting all data, remotely controlling and programming the MA&P over a compatible two-wire local area network to a central personal computer for storage, analysis, display, and printout. The network shall also be capable of transmitting data in RS232c format via a translator module. The following minimum functions shall be available through communications at the personal computer with appropriate Windows-based software:

    a. Monitoring and trending of all locally displayed values and device status.

    b. Initiating an Event/Alarm.

    c. Retrieving Event/Alarm Information.

    d. Retrieving Harmonic Analysis/Wave Form Analysis information including construction of the Harmonic Profile to graphically display simultaneously the relative magnitudes of the multiples of the fundamental frequency for both current and voltage of a given phase.

    e. Retrieving Harmonic wave form analysis information for display of eight-cycle wave shapes of all simultaneously recorded current (phase A, B, C, N, and G) and voltages L-L and N-G.

    f. Activating relay output contacts.

    g. Programming device configuration and setpoints.

    h. Synchronizing device clocks to within 30 milliseconds (for demand windows and time stamping).

F. Transducers:

1. Furnish and install watts, current and voltage transducers where shown on the Contract Drawings. The transducers shall be UL recognized, have an accuracy of 0.2% of reading and 4-20MAdc outputs. Current inputs shall be 0-5A and voltage inputs shall be 120V. Transducers shall operate on 120V power.

2. The transducer outputs shall drive the Control Room mimic board meters.

3. Transducers shall be Scientific Columbus, Type Exceltronic II XLG, or approved equal.

2.11 FULLY-EQUIPPED SPACE FOR FUTURE BREAKER

A. Spaces indicated for future breakers shall be provided with complete wiring, terminal blocks, and mounting provisions for future breakers, current transformers, metering, including all outgoing wiring for future remote breaker control, alarm, and indication. Two (2) 12-point terminal blocks shall be provided as spares. Drilling provisions for switches, meterings, etc. on compartment doors are not required.

B. Spare breakers shown without current transformers and metering shall have complete wiring the same as defined for fully-equipped spaces.

2.12 CIRCUIT BREAKER TEST CABINET

A. One test cabinet shall be furnished for inspection and test of the removable vacuum circuit breaker elements. The cabinet shall be furnished with a control switch and indicating lights to permit operating the breaker electrically from the cabinet and shall also include a plug and cable for connection to the breaker. Test cabinet shall be mounted within Electrical Room and be completely wired.

2.13 KEY INTERLOCK SYSTEMS

A. Key interlock systems shall be provided as indicated on the Contract Drawings and as specified herein.

1. At each double-ended switchgear lineup, the key interlock system shall be designed to prevent paralleling of the two incoming sources.
2. Contractor shall furnish and install the interlock components at each switchgear to ensure the completeness and satisfactory operation of each system.
3. There shall be clear access to all key interlocks. Wires shall be routed such that they do not hinder the clear access to the key interlocks.
4. Key interlock system manufacturer shall be Kirk, or approved equal.
5. Rearrange and add key interlocks on 5 kV switchgear as shown on the Contract Drawings.

2.14 DC CONTROL VOLTAGE SYSTEM

A. The switchgear control voltage shall be 125 VDC consisting of batteries, battery charger, battery racks, DC distribution panels and DC automatic transfer switches.

B. The battery system shall be a flooded (wet cell) lead acid product with 20 year life expectancy. Each jar shall be constructed of clear styrene acrylonitrile copolymer and contain one cell. The positive plates shall be no less than .34 inches thick and must be bridge hung to allow for grid growth without compromising jar integrity. Plate separators shall be made of microporous rubber. The jar cover shall be made of material with a minimum Limiting Oxygen Index of 28%. A fused alumina flame arrestor/vent shall be supplied for each cell.

C. The cell post shall be designed with two seals. The first seal shall be an acid resistant epoxy to adhere the post to the post well insert. The second seal shall be an O-ring design allowing the entire seal structure freedom of movement due to changes in internal cell pressure, temperature, aging, shipment, and seismic events. Neither seal shall use heat for adhesion.

D. Intercel connectors shall be of lead coated copper busbar. Inter-rack and inter-tier cables shall be flexible insulated copper multistrand conductors with hydraulic compression lugs. All nuts, bolts and washers shall be grade 316 Stainless Steel. A portable hydrometer with wall hangar and drip cup and an electrolyte thermometer shall be supplied with the battery.

E. The battery shall supply a minimum of 624 amperes for a period of eight (8) hours, 548 amperes for a period of four (4) hours down to an end voltage of 1.75 vpc at 77EF. The battery shall be Exide type EC11 as manufactured by Exide, Inc. or an equal approved by the Engineer.

F. All battery suppliers shall use the battery manufacturer's local technical support and service employees (not third party service) for installation and maintenance of the product. All suppliers shall have an EPA approved disposal program for environmentally safe recycling of lead acid batteries.

G. The batteries shall be configured to produce 125 VDC. The manufacturer shall furnish calculations showing the proposed batteries have sufficient capacity to properly power the switchgear equipment. Batteries will not be approved without sizing calculations.

H. Battery racks shall be furnished and installed to support all batteries. Racks shall be configured as required to fit into the battery rooms, as shown on the Contract Drawings. The Engineer shall approve all rack configurations. Battery racks shall be no higher than 60".

I. The battery racks shall be steel with powder-coated ANSI 61 gray acid-resistant epoxy paint. All rails shall be insulated with plastic channel. All hardware shall be zinc-plated steel.

J. Each rack of batteries, or group of racks, shall be provided with a liquid tight 4-inch deep spill control barrier which extends at least 1 inch beyond the battery rack in all directions. An approved method to neutralize spilled electrolyte shall be provided. The method shall be capable of neutralizing a spill from the largest battery to a pH between 7.0 and 9.0.

K. The spill containment system shall consist of the following:

1. Shall be a minimum of a 4-inch high barrier.
2. Shall be made of 28 LOI PVC material.
3. Each neutralizing and absorbing pillow shall be capable of absorbing 5420cc of 1.300 sp. gr. electrolyte.
4. Each neutralizing and absorbing pillow shall be capable of neutralizing 57% of the volume absorbed.
5. Each pillow shall be a minimum of 1 foot square and 3.5 inches thick.
6. The battery manufacturer shall provide the Spill Containment System.

L. Each battery system shall have a battery charger sized for 150% of total load (load as calculated in paragraph G. above) to keep batteries at their proper voltage. The chargers shall be float type, filtered silicon rectified controlled. Rectifiers shall automatically control charging rates and shall provide full rated output for both continuous and intermittent loads.

M. Charger cabinets shall be NEMA 1 rated with recessed front panel, shall be constructed from heavy gauge phosphatized steel and shall be painted with an acrylic enamel finish.

N. Control circuits, alarms and sub-assemblies shall be printed circuit board wired or wire and socket connected for easy serviceability. Hinged doors shall open 180 degrees for easy access to components.

O. Chargers shall be capable of operating as a DC power supply without batteries.

P. The chargers shall have the following features:

1. AC Input: 120V thru 480V.
2. Output Voltage Regulation: ±5%. For input variations of ±10%

   For input frequency variations of ±5%

   For load variations of 0 to 100% ±10% for combined variations of line, load and temperature.
3. Output Transient Response and Recovery: ±5% maximum with step load changes from 20% to 100%. Recovery to steady state DC voltage setting in 500 milliseconds ±2% in 200 milliseconds.
4. Output Voltage Ripple Content: 30 MV or less.
5. AC Input Protection: Circuit breaker.
6. DC Output Protection: 2 pole circuit breaker with redundant single pole fuse.

7. DC Output Current Limit: 120% rated operation. Factory set at 110%. Adjustable from 90% to 120%.

8. Rectifiers: Silicon controlled rectifiers with MOV surge protector.

9. DC Output Ammeter and Voltmeter: 2% accuracy, 3.5 inch case standard.

10. DC Surge Arrestor

11. Status indicating lights and switches.

12. Power isolation transformer.

13. Alarm indicating lights and contacts for remote indication for high/low DC voltage, high/low AC voltage, ground detection, charger failure (no DC current), common alarm relay.

14. Additional alarm contacts for battery discharging, end of discharge, and DC current limit.

Q. Chargers shall be equal to Exide, Inc., "Type SCRF".

R. DC panels shall conform to the requirements of Specification Section 16441 - Panelboards.

S. DC automatic transfer switches shall be rated 125 VDC and 150A. Switches shall conform to Section 16496 - Automatic Transfer Switches, (all alternating current specifications do not apply to DC automatic transfer switches). Transfer switches shall be UL listed under UL 1008, "Standard for Safety for Automatic Transfer Switches". Switches shall be Automatic Switch Company, "Type 432".

2.15 5 kV HMI MIMIC PANEL

A. An HMI mimic panel mounted on the wall in Electrical Room 201 at the location indicated on the contract drawings near the egress staircase door. The HMI mimic panel shall collect signals from the 5kV gear, 480V gear, and 480V distribution board. The graphic, touch screen display shall show the single line diagram for the building. This screen shall display all electrical characteristics of breakers and buses and identification of and loads served by each breaker.

B. Each switchgear breaker shall be controlled from the HMI mimic panel and the screen shall indicate breaker status as either green, red or amber indicating lights to display that the breaker is open, closed or tripped, respectively.

C. HMI mimic panel shall be capable of generating an audiovisual alarm for selected off-normal conditions and shall log time stamp of the event.

D. The Contractor shall submit all details of the HMI mimic panels including the display, equipment layout, wiring, and materials, for Engineer approval.

E. The HMI mimic panel shall have analog meters for voltage, current, and power.

F. The HMI mimic panel shall output the collected information via one (1) ethernet cable to the headend located in Control Room 101 which shall distribute the collected information back to the Energy Management Control System (EMCS) located within the Main Substation (MSS) via the fiber optic communication loop. The new electrical equipment and associated HMI mimic panel shall be compatible with the existing EMCS such that all monitoring and control functionality is available at the EMCS in the MSS.

G. Coordinate communications protocol and any required communications converters required with existing EMCS manufacturer and new equipment manufacturer.

H. Equipment supplier shall coordinate with the Power Controls Systems Supplier for VLAN and IP assignments as required to facilitate complete communication between EMCS and Power Controls System (PCS).

2.16 PROTECTIVE EQUIPMENT AND TOOLS

A. The Contractor shall furnish five (5) sets each of protective equipment and tools. Protective equipment shall consist of:

1. Flash Coat - 6 oz. Nomex with Velcro fasteners
2. Arc Hood
3. Gloves
4. Face Shield
5. Safety Helmet
6. Safety Glasses
7. Carrying case for the above equipment

C. Protective tools shall consist of:

1. Grounding Stick
2. Voltage Tester
3. Hot Sticks
4. Grip All Clamp Stick
5. Grounding Clamps - Ball and Socket Type - ASTM Type 1, Class A, Grade 5
6. Ground Stud Covers.

D. Contractor shall provide one (1) day of training for twenty (20) County personnel in the use of all protective equipment and tools.

2.17 PAINTING

A. Paint shall be in accordance with Specification 09900.

B. The finish shall consist of a coat of Grey (ANSI 61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphated steel and aluminum for internal and external parts. The coating shall have corrosion resistance of 600 hours to 5% salt spray. Prior to shipment, the complete assembly, indoor as well as outdoor, shall be given 1.5 to 2.0 mil thick exterior finish spray coat of air drying high-gloss grey enamel.

2.18 SHOP TESTS

A. Certified Shop Tests

1. Test equipment to demonstrate that it has been properly assembled, properly lubricated, is not overheating, is not overloading, and has no electrical or mechanical defects.
2. Perform all certified shop test and submit the shop test reports prior to scheduling the witness shop test.
3. The following standard factory tests shall be performed on the circuit breaker element provided under this section. All tests shall be in accordance with the latest version of ANSI standards.
    a. Alignment test with master cell to verify all interfaces and interchangeableness.
    b. Circuit breakers operated over the range of minimum to maximum control voltage.
    c. Factory setting of contact gap.
    d. One-minute dielectric test per ANSI standards.
    e. Final inspections and quality checks.
4. The following production test shall be performed on each breaker housing:
    a. Alignment test with master breaker to verify interfaces.
    b. One-minute dielectric test per ANSI standards on primary and secondary circuits.
    c. Operation of wiring, relays and other devices verified by an operational sequence test.
    d. Final inspection and quality check.

B. Witnessed Shop Tests:

1. The Contractor shall perform witnessed shop tests in accordance with General Conditions Article GC-19.

2. Shop testing shall be performed on the switchgear at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of ANSI and shall demonstrate that the equipment tested conforms to the requirements specified. All shop testing will be witness by three (3) County representatives.

3. The Contractor shall include the cost for three (3) County representatives (airfare, food, hotel – one occupant per room, and transportation) to attend and witness all factory shop tests.

4. The Contractor shall provide a certified shop test report. The report shall identify the tests performed and the results obtained.

5. Obtain approval of the testing procedure and test stand layout prior to scheduling a witness shop test.

6. The Contractor shall submit and obtain acceptance by the Engineer of the witness shop test report prior to shipment of the equipment.

2.19 RUBBER MATS

A. Surface mats shall be of prime quality rubber compound, free of calendaring and curing defects and shall be resistant to weather, aging and ozone in normal concentrations. Mats shall be 5/8-inch thick and shall be custom made to sizes shown with beveled edges.

B. Floor mats shall be furnished and installed along the entire front of each switchgear furnished and installed under this Contract, i.e., a continuous run along the front of the Medium Voltage Metal-Clad Switchgear.

C. Mat shall be black with yellow safety stripe on edge as manufactured by American Floor Mats, series double-duty anti-fatigue mats.

2.19 UNIVERSAL REMOTE POWER RACKING MECHANISM

A. This specification covers the requirements for the installation and operation of a remote racking mechanism for use with circuit breakers mounted in medium voltage switchgear. The performance requirements are covered in the specification. The

product design, manufacturing and testing are the responsibility of the manufacturer of the racking system. Racking or levering, for the purpose of this specification, is defined as the process of inserting and/or removing a power circuit breaker from its cell structure or cubicle by utilizing a crank type device that interfaces with a rotating screw or gear driven system (rotary screw type racking). The remote power-racking mechanism shall have all major components contained within a common integrated system. Adapters and interfaces for specific applications may be separately mounted. The system shall be designed to allow the operator to be a safe distance away from the calculated arc flash boundary as determined in the Arc Flash Hazard Analysis and to limit exposure from projectiles that may be expelled from the front of the switchgear cubicle during an arc flash event.

B. The remote power racking mechanism shall be manufactured in an ISO9001: 2000 certified facility. The equipment shall conform to, and tests shall be conducted in accordance with, the latest revisions of applicable standards of the American National Standards Institute (ANSI), National Electrical Manufacturers' Association (NEMA), and the Institute of Electrical and Electronic Engineers, Inc. (IEEE) unless otherwise stated herein.

C. The remote power racking system shall be suitable for use in existing switchgear. The design, installation and performance of the remote power racking system shall be in accordance with the requirements of IEEE/ANSI C37.20.2 for the components installed within a switchgear compartment. The complete system (including the medium voltage circuit breaker modifications) shall be tested in accordance with IEEE/ANSI C37.59. The design testing shall be formed on the complete assembly, in the switchgear compartment and the system shall be capable of performing a minimum of 250 racking operations.

D. Power to operate the remote power racking system shall come from an onboard uninterruptible power supply (UPS) with battery backup. The UPS shall be fed from standard 120Vac, 60 Hz receptacles rated a minimum of 15A. The UPS shall provide portability to the system when receptacles are not available and shall have sufficient energy to consecutively rack a minimum of 40 circuit breakers of any manufacture or rating on a single full charge. The UPS shall be capable of being connected to a receptacle for charging at all times and shall be capable of simultaneously charging and racking power circuit breakers.

E. The remote power racking system shall be rated to allow for racking of the drawout circuit breaker without overheating, operate the shutter mechanism in the circuit breaker compartment and generate adequate forces to make or break the primary and

secondary connections of the medium voltage circuit breaker during the racking operation.

F. The mechanism shall be sized to operate the existing circuit breaker interlocks. The remote racking mechanism shall contain the functionality of the exiting circuit breaker interlocks and the new modified circuit breaker interlocks. The remote racking mechanism shall be designed to be capable of moving the medium voltage circuit breaker between the CONNECTED, TEST and DISCONNECTED positions. The remote power racking mechanism shall also have provisions to allow the circuit breaker to be open and close the circuit breaker mechanism in the TEST position.

G. The medium voltage circuit breaker shall be maintained in the "trip free" condition during the racking operation between the CONNECTED and TEST positions. Closing and tripping mechanisms shall operate satisfactorily over the voltage range in accordance with ANSI C37.06, table 10.

H. The remote power racking system shall include of the following components unless otherwise specified:

a. Racking actuator with motor in each cell.
b. Circuit breaker guide.
c. Circuit breaker "quick disconnect" device.
d. Limit switches.
e. Control wiring disconnect.
f. Manually operable remote control unit.

I. A mechanical torque-limiting device shall be mounted to the output shaft of the remote power racking unit and calibrated to a higher torque than the maximum electrical torque limit. The mechanical torque limiter shall be used as a backup to the electrical torque limit to prevent damage to the breaker or cell during the racking process.

J. The racking torque shall be factory programmed and field selectable for each type of breaker included in the racking program. The limit settings shall be less than the mechanical torque limit for all program settings.

K. The remote power racking system shall be designed such that the racking system can be easily moved between various switchgear assemblies. It shall be equipped with a set of wheels to allow movement over rough floor surfaces and door seals, as well as gravel-covered switchyards. The remote power racking system shall be capable of rolling parallel to the switchgear doors for easy positioning in front of individual cell structures. A "hand truck" type transport system is not acceptable as a means of positioning and alignment due to limited access in front of some assemblies.

L. The remote power racking system shall be provided with a remote, hand held, operator pendant containing a momentary insert push button, a momentary remove push button, and a single amber indicating light. Connection of the pendant to the power module shall be via a 25-foot umbilical cord with a military grade metal screw connector.

M. The remote power racking system shall be provided with an easily visible three-color stack light mounted on the Power Module. The light shall display operational sequences and provide flashing warning lights to alert personnel within the switchgear room that circuit breaker racking is in progress or if a racking operation has encountered difficulties.

N. A breaker interface adapter shall be provided for each type of breaker included in the racking programs. Adapters shall be easily attached and removed and shall interface with a standard 1/2-inch square drive.

O. Horizontal Traversing and Racking Pressure: The remote power racking system shall have the capability to apply linear horizontal force of up to 10 pounds against the levering shaft of the circuit breaker during the racking process. The racking system shall also be capable of horizontally traversing up to 15-inch to follow the insertion or removal of a power circuit breaker. The force shall be relatively constant as the RPR shaft traverses. The traversing and racking pressure system shall be mechanically latched in the collapsed position for transport or when the system is not in use. When the traversing shaft is released, it shall have a damped motion to prevent injury to operating personnel.

P. Programming: The RPR shall be capable of storing up to eight different racking programs. The power module shall be loaded with all applicable racking programs prior to shipment. Access to the programming shall be via a standard personal computer and serial port. The programs may be upgraded or replaced with different sets of racking parameters via a factory-supplied compact disk (CD). The RPR

programming system shall be designed such that the circuit breaker racking programs are protected from alteration or accidental deletion during normal operation.

Q. The power module's height shall be adjusted without the use of winch or motor operated systems. Height adjustment shall require approximately 10 pounds of upward or downward force and shall remain at rest when no adjustment force is applied.

R. The system shall be provided with alignment features and wheel locking devices to prevent movement during the racking process.

S. The power module shall be equipped with a transport lock to secure the power module at its lowest point during transportation or movement.

T. The remote power racking system shall be capable of allowing closed door racking of any power circuit breaker that has rotary screw racking, provided the proper breaker racking adapters are furnished. The switchgear shall be modified with the opening of a 2-inch hole on the front door to allow for closed-door racking capability, the remote power racking system shall be designed to allow this feature. Cell door modifications shall be provided as required.

U. Breaker Racking Adapters: The remote power racking system shall be provided with breaker racking adapters to interface between the remote power racking system and the existing breaker racking system. Adapters shall be capable of temporarily operating existing breaker interface devices that must be engaged before and during the process of racking circuit breakers to and from the fully connected position.

V. Breaker Racking Adapter Storage Compartment: The remote power racking system system shall be designed to have adequate storage space for circuit breaker racking adapters and remote umbilical cord.

W. The remote power racking system shall be provided with a protective cover to protect the racking system electronics from normal environmental contamination and dust. The cover shall be capable of quick removal and replacement using Velcro fasteners.

X. The remote power racking system shall include a circuit breaker racking failure feature. This feature shall include immediate reversal of the racking system if an

error/interference is detected during the process of insertion, blocking remote control from the operator pendent, locking out racking controls until the racking problem has been investigated and the racking system has been reset. The three-color stack light shall flash alternately until the system is manually reset.

Y. The remote power racking system shall have a nameplate made of metal-coated film with laser printed information. The nameplate shall include the general order number, warranty expiration date, a factory-direct toll-free contact number and any other pertinent information necessary to identify the remote power racking system.

Z. A total of two remote power racking systems shall be provided:

a. One for the First Floor MSS Electrical Room.

b. Spare

AA. The remote racking power system shall be the RPR-2 as manufactured by the Eaton Corp. or approved equal.

BB. Contractor shall provide one (1) day of training for twenty (20) County personnel in the use of all protective equipment, tools, and remote racking device.

PART 3 EXECUTION

3.1 NAMEPLATES

A. Labeling and identification shall be in accordance with Section 16076, Labeling and Identification, and as specified herein.

B. Nameplates shall be provided for each circuit breaker. Each nameplate shall be laminated plastic 3/32 in. minimum thickness, 1 inch high and 3 inches wide. The plate shall be white with 3/16 inch high engraved black lettering. All four front edges shall have a 1/16-inch bevel. Each nameplate shall be fastened to the compartment door with two stainless steel self-tapping screws. Nameplate inscriptions will be specified by the Engineer. In addition, a nameplate shall be provided for each unit substation or switchgear line-up of the same material and construction except that the lettering shall be 1/2-inch high.

C. Laminated plastic nameplates, legible from floor level, shall be provided for all enclosures and control items such as meters, relays, switches, fuses, control power transformers, panelboards, pilot lights, etc.

3.2 FIELD TESTS

A. The Contractor shall engage the services of an independent testing firm, as described in General Specification 16292 - Power Distribution System Coordination, to set all protective relays and devices based on the short circuit and relay coordination study.

B. After installation of the equipment, controls and all appurtenances, field test the equipment for system operation and conformance to the specified performance parameters. The Contractor shall perform field tests in accordance with Article 12 of the General Conditions and Division 1 - General Requirements. Test the equipment to demonstrate the following:

1. Equipment has not been damaged in transportation and installation.
2. Equipment has been properly installed.
3. Equipment has been properly lubricated.
4. Equipment has been properly connected.
5. Equipment is not overheating.
6. Equipment is not overloading any part.
7. The equipment has no electrical or mechanical defects.
8. Compliance with performance and design parameters.
9. System operability under all control schemes.
10. Battery systems shall undergo field test to ensure a complete system in working order. The field test shall replicate the battery system shop test.
11. All equipment and terminations shall be tested in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology and the NETA acceptance testing specification.

3.3 MANUFACTURER'S FIELD SERVICES

A. The Contractor shall furnish the services of a qualified manufacturer's service representative to assist in the installation of equipment, check the installation before it is placed into operation, assist in the performance of field tests, observe and assist initial operations and train the plant operations and maintenance staff in the care, operation and maintenance of the equipment.

B. The Contractor shall provide equipment start-up services and training in accordance with Section 01821 and as described in this Section.

C. The Contractor shall provide the services of the representative for the following minimum durations:

1. Equipment Installation and Inspection2 visits of 5 days each
2. Field Tests: Two visits of 5 days each
3. Initial Operation: Two visits of 5 days each

4. Training: Two visits of 5 days each

D. Reports: The Contractor shall submit a report from the manufacturer of each visit to the site. The Contractor shall provide complete information on time, schedule, tasks performed, persons contacted, problems corrected, test results, training, instruction, and all other pertinent information.

E. All service representatives shall sign in with the Engineer on each day they are at the construction site.

+ + END OF SECTION + +

SECTION 16294

MEDIUM VOLTAGE SOLID STATE STARTERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnish and install solid state starters as shown on the drawings and as specified herein, including all required appurtenances. The solid state starters shall be microprocessor controlled, suitable for use with three phase induction motors rated 4,160 VAC or less. The starter(s) shall provide closed loop current ramp control or true-torque control for smooth and stepless motor acceleration and deceleration.

1.2 RELATED SPECIFICATIONS

A.	Specification 16036	-	Testing
B.	Specification 16071	-	Supporting Devices
C.	Specification 16076	-	Labeling and Identification
D.	Specification 16292	-	Power Distribution System Coordination
E.	Specification 16293	-	Medium Voltage Metal Clad Switchgear
F.	Specification 16911	-	Electrical Monitoring and Control System

1.3 QUALITY ASSURANCE

A. General
   1. The solid state soft Starters shall be designed, built and tested in accordance with the latest applicable editions of ANSI/IEEE, NEMA, UL, and NFPA.
   2. All structures shall be fabricated of code gauge steel. Steel surfaces shall be chemically cleaned, treated and finished with ANSI No. 61 indoor light grey paint.
   3. The solid state soft starter manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all factory tests. Calibration of testing apparatus shall be within one year.

4. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology and the NETA acceptance testing specification.

5. The solid state soft starter shall be designed, constructed and installed suitable for earthquake regulations in accordance with the seismic requirements of the Nassau County Building Code and the Uniform Building Code for zone 2A application.
6. Products used in the work of this Section shall be produced by manufacturers regularly engaged in the manufacturing, installing and servicing of similar items with a history of successful production acceptable to the Engineer as specified herein and in accordance with Article 5 of the General Conditions.

B. The solid state starters shall be the product of a manufacturer who has produced medium voltage solid state starters of the same type and size for a minimum of 5 years consecutive. A Users List, complete with telephone numbers and contact persons shall be furnished for verification.

C. For safety, reliability, and continuity of warranty, any modifications, alterations, etc. required to conform to the requirements of this specification shall be performed by the Starter Manufacturer only. Distributor or other third party modifications to a Manufacturer's standard product are specifically disallowed. The solid state starters shall be manufactured by Benshaw Inc., General Electric Company, Cutler Hammer, or approved equal.

D. Solid state starters shall be UL 347 listed and factory labeled. Field labeling is not acceptable.

E. Solid state starters shall be factory labeled for ElectroMagnetic Compatibility. Field labeling is not acceptable.

F. The solid state starter shall be designed, manufactured and tested to conform, where applicable, to the following industry standards and specifications:
   1. ANSI
   2. CSA
   3. EEMAC
   4. IEEE
   5. NEC
   6. NEMA ICS2
   7. OSHA
   8. UL 347

G. Environmental Requirements:
   1. Temperature: 0 – 40o C (32o F to 104o F)
   2. Relative Humidity: up to 95%, non-condensing
   3. Suitable for use in H2S concentrations per OSHA regulations for continuous worker exposure.
   4. Input Power: 2.4kV-4.16kV AC, 3Ph, +/- 10% 50-60 Hz, +/- 3Hz.
   5. Meet Uniform Building Code on non-building structures, section 2338 for zone 1, 2, 3, and 4 requirements.

H. The starter must be matched to the specific load requirements of the blower/motor combination. The starter must be compatible with the blower/motor requirements specified in the Contract Specifications.

I. Field Tests
   1. The medium voltage solid state starters shall be field tested. Field testing shall be performed in accordance with the requirements specified under article 3.02.
   2. The services of the medium voltage solid state starters manufacturer shall be retained for field service. Field service shall be in accordance with the requirements specified under Article 3.03.
   3. Retain the service of an independent testing firm who shall perform field acceptance testing of the medium voltage solid state starters. The testing firm shall have experience in the inspection and testing of the equipment and shall be a member company of NETA. Provide proof of membership, or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer. Acceptance testing shall be in accordance with the requirements specified under Article 3.04.

1.4 PAYMENT

A. Payment for medium voltage solid state starters shall be made as provided for in the Specifications.

1.5 REFERENCES

A. Medium voltage solid state starters shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70 - National Electrical Code
   2. ANSI - American National Standards Institute
   3. IEEE - Institute of Electrical and Electronics Engineers
   4. NEMA - National Electrical Manufacturers Association

5. NFPA - National Fire Protection Agency
6. UL - Underwriters Laboratories
7. NETA - International Electrical Testing Association

1.6 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article 4 – Contractor's Working Drawings, Design and Shop Drawings; and as specified under Division 1 of the Specifications.

B. Working Drawings
1. Product data sheets identifying all materials used and methods of fabrication.
2. Complete assembly, layout and installation drawings with clearly marked dimensions.
3. Elementary wiring, interconnection diagrams and point-to-point wiring diagrams in accordance with NEMA ICS standards.
4. Size, type, and rating of all system components including the interrupting, withstand, and continuous current rating of:
   a. Starter Units
   b. Incoming Line Units
5. Weights of all component parts, assembled weight of units and approximate total shipping weight.
6. Enclosure frontal elevation and dimension drawings.
7. Internal component layout diagrams.
8. Available conduit entry and exit locations.
9. Manufacturer's product data sheets.
10. Certification of conformance to "Buy American" steel acts.
11. Certification of H2S withstand, per 1.02.F.3.
12. UL 347 certification file number.
13. List of Spare Parts
14. List of Special Tools
15. Painting procedures
16. Installation instructions
17. System O&M Manual
18. Medium Voltage Solid State Starter anchorage details with design calculations signed by licensed Engineer.

C. Testing Methods
1. The Contractor shall submit description of shop and field testing methods, procedures and apparatus with calibration dates. Testing methods and

procedures shall be submitted at least 45 days in advance prior to conformation of witness testing dates and actual testing.

2. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least 45 days in advance to actual testing, five recent references with phone numbers shall be submitted.

D. Certificates of Compliance
   1. Seismic qualification certificate from the manufacturer including mounting recommendations.
   2. Data and results of witness tests accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed.

E. Reports
   1. Shop test and field test reports shall be submitted.
   2. Manufacturer's site visit and acceptance testing reports shall be submitted.

F. Operation and maintenance manuals shall be submitted in accordance with the Specifications.

1.7 DELIVERY, STORAGE AND HANDLING

A. Medium Voltage Solid State Starter equipment shall be delivered, stored and handled in accordance with the Specifications, the manufacturer's instructions and the following.
   1. Medium voltage solid state starter equipment shall be inspected for shipping damage or loose parts when received. Evidence of water which may have entered equipment during transit shall be checked.
   2. Medium voltage solid state starter equipment shall be lifted, rolled or jacked into locations shown on the Contract Drawings.
   3. Handling and shipment of the equipment shall be in such a manner to prevent internal component damage, breakage, and denting and scoring of the enclosure finish.
   4. Medium voltage solid state starter equipment shall be stored in a clean, dry location in which a uniform temperature is maintained. Equipment shall be protected with coverings and maintain air circulation. Storage parameters shall be as follows:
      a. Ambient Temperature Range 32°F - 140°F
      b. Temperature Rate of Change 6°F in 30 Minutes
      c. Humidity (Non-Condensing) Range 20% - 95%

d. Humidity Rate of Change 10% in 30 Minutes

5. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.

1.8 SPARE PARTS

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the medium voltage solid state starters in accordance with the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts shall be furnished in accordance with the manufacturer's recommendations. Spare parts shall include as a minimum:
   1. One each of each type of Printed Circuit Board.
   2. One of each type and size of control fuse
   3. Three of each type and size of power fuse
   4. One complete spare Power Cell of each type and size used
   5. One complete spare RTD monitoring device

1.9 SYSTEM DESCRIPTION

A. In general, the medium voltage solid state starters included under this Section shall include, but not be limited to, the following:
   1. Medium voltage fused disconnect switch
   2. Power factor correction capacitor compartment
   3. Input, output, and bypass contactor compartment
   4. Low voltage controls isolated compartment
   5. Medium Voltage solid state soft start compartment
   6. Enclosure

1.10 DESIGN REQUIREMENTS

A. The Contractor shall review installation procedures under other Sections and Contracts and coordinate them with the work specified herein.

B. The Contractor shall notify other Prime Contractors in advance of the installation of the work included to provide them with sufficient time for installation and

coordination of interrelated items that are included in their contracts and that must be installed in conjunction with the work included in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers shall be as follows:
   1. ABB - Benshaw
   2. Square-D
   3. Eaton
   4. Or approved equal.

B. Note that all specified Manufacturers are obligated to meet the detailed requirements of this specification. Any proposed exceptions must be clearly stated at bid time, citing the reason for noncompliance, and the cost for providing a conforming product. Failure to provide a detailed list of proposed exceptions may cause a bid to be deemed non-responsive. The Engineer and the Owner will be the sole determiner of the acceptability of a proposed exception. In no case will adjustments to the Contract Price be allowed later for conformance to the Specifications.

2.2 GENERAL

A. Each medium voltage solid state starter shall be rated for the voltage and ampacity as shown on the Contract Drawings, specified herein, and shall have 5kV insulation on all parts in accordance with NEMA standards.

B. The specified current rating shall be a continuous rating when the switch is installed in an unventilated enclosure, and shall conform to NEMA temperature rise standards.

2.3 EQUIPMENT DESIGN CRITERIA

A. The Medium Voltage Solid State Starters shall conform with the following:
   1. Size: 1250 HP
   2. Minimum Overload Rating: 400% of Starter FLA for 30 seconds
   3. PIV Ratings, 4,160 VAC: 13KV
   4. Rated Short Circuit Amps: 50 KA RMS SYM
   5. Overall Efficiency w/Bypass: 99.94%
   6. Transient Voltage Protection: dV/dT circuits / phase
   7. Under voltage Protection: 80% Pickup; 60% Dropout

8. Control Input: 120 VAC or dry contact, 2/3 wire
9. Starts Per Hour: Maximum of 3 30-second starts
10. Max Time Between Restarts: Not less than 20 minutes
11. Audible Noise: Not to exceed 60dbA @ 1 meter at any time

2.4 ENCLOSURE CONSTRUCTION

A. Construct to comply with NEMA Part ICS 2-324 as Class E1 controller. Disconnect section shall conform to Class E2 controller.

B. Basic structure shall be welded type construction utilizing minimum 11 GA sheet metal. All steel shall conform to applicable "Buy American" regulations.
   1. Doors shall be minimum 11 GA sheet metal, pan type with flanges formed to provide sturdy, rigid structure.
   2. Provide door interlocks to prevent doors from being opened with power applied.
   3. Doors shall be hinged to allow 120° swing.
   4. Total structure height shall not exceed 92"

C. The solid state starter enclosure shall be indoor, NEMA 12. Enclosure shall be as follows:

   1. The Starters and any required accessories or auxiliary items shall fit within the space shown on the Plans. Any costs associated with furnishing equipment which exceeds the available space shall be borne by the Contractor. Enclosure dimensions per unit shall be maximum 45"w+30"d each starter. Enclosure height shall not exceed 92 inches with additional height required for top mounted unit line reactor.
   2. Provide removable lifting provisions.
   3. Each Solid State Starter Motor Controller shall consist of the following:
   4. Starter Cabinet (92"H+36"W+30"D maximum enclosure dimensions) shall contain the following:
      a. Vacuum inline and vacuum bypass contactors.
      b. Auxiliary metering and control devices as shown on the Contract Drawings
      c. Low voltage control panel.
      d. Vacuum contactor for externally fused and mounted power factor correction capacitors.
      e. Cable Entry: Top
      f. Cable Exit: Bottom
   5. Power Factor Capacitor Cabinet (92"H_26"W+30"D maximum enclosure

dimensions) shall contain the following:
a. Contactor
b. Power factor capacitor – rating to be determined based on 1250HP, 4.16kV, 3P, 4W blower.

D. Finish shall be as follows:
1. Metal parts to be given thorough rust resistant treatment.
2. Primer shall be S-W recoatable epoxy primer B-67 Series
3. Finish shall be S-W high solid polyurethane polate T plus F63 series
4. Color shall be ANSI 61 Gray.

2.5 WIRING

A. Complete with internal power and control wires including terminations for external connections. Phase sequencing shall have proper identification and control wires shall have suitable markings at terminations.

B. Adequate space shall be allowed for the Contractor installation of stress cones for medium voltage cable terminations during the wiring of the starter.

2.6 MEDIUM VOLTAGE COMBINATION STARTER

A Main Isolation Switch:
1. Externally operable, ganged 3 pole load break, fault make unit. In addition the switch shall interrupt no-load current of control transformer supplied in controller. In off position, the switch shall ground some medium voltage power components, discharging hazardous stored energy, to provide safer operation and maintenance.
2. Operational Features:
a. Two N.O. and Two N.C. auxiliary contact.
b. Remain connected to external operating handle at all times, fully interlocked with inline contactor to prevent operation with doors open.
c. Capable of being padlocked in open position with up to three locks.
d. Mechanically and/or electrical interlocked to prevent opening of medium voltage door when isolating switch is in the closed position and prevent closing of the isolating switch when medium voltage door of starter is open.
e. Removes power to coil of inline and bypass contactor before removing line power during manual operation of the disconnect to open incoming power.
f. Viewing window shall be installed to verify state of the switch.
3. Required Ratings:

a. Rated interrupting current, RMS: 1200 Amp load break.
b. Continuous current, RMS: 1200 Amp Cont.
c. Impulse withstand: 110 kV
d. Momentary current, RMS: 63 kA (asymmetrical)
e. Short-time current RMS: 63 kA, (2 sec.)
f. Fault closing current w/CL Fuses 63 kA (symmetrical)

B. Power Fuses & Holders
1. Current limiting type rated 63 kAIC symmetrical at max. 5 kV.
2. Fuse size shall be manufacturer's standard.
3. Fuses shall be vertically mounted in the front of the enclosure for ease of inspection and removal without special tools.
4. Provide blown fuse indication.
5. Power fuse holders shall be clip-in style, part of starter assembly
6. Fuse clips shall be designed to accept current limiting fuses for Class E2 operation.

C. SCR Stacks:
1. Arranged vertically for proper heat management.
2. Heat sinks sized for specified Starts Per Hour without requiring auxiliary cabinet cooling fans.

D. SCR Gating: Provide fiber optic cable gating signals to SCR stacks for safe isolation of control and power circuits and precision control of seriesed SCRs.

E. An inline (main) contactor and a bypass contactor shall be provided.
1. Vacuum break type, fixed mounted style.
2. Current rating: manufacturer standard for horsepower rating
3. Voltage rating: Up to 14,400 VAC.
4. The main and/or bypass contactor shall be sequenced by the Starter manufacturer for proper operation of the solid state starter.
5. The bypass contactor shall bypass the SCRs after starting and while the starter is in the run (full voltage) mode.

F. Exterior surfaces of NEMA 12 enclosures shall be painted gray, ANSI 61. Interior surfaces shall be painted white.

2.7 CONTROL DEVICES

A. Control Power Transformer
1. Provide an appropriately rated internal 4.16kV-120VAC stepdown transformer, mounted separately in the medium voltage power section.

2. Supply two fuses on primary and one fuse on secondary side with one leg grounded.
3. Disconnect primary of control transformer from power supply with isolating switch in open position.
4. Control transformer shall be sized to accommodate all system requirements.

B. Control Wiring: Shall be tinned copper, SIS type, minimum 12 AWG stranded rated for 600 V.

C. Terminal Strips:
1. Control: For contractor field connections, terminal blocks shall be stud type to accept insulated, fork tongue terminals.
2. Current Transformer: Terminal blocks shall be shorting C.T. type.

D. Push buttons, pilot lights, and control relays, heavy duty, rated to 600 V push-to-test.

E. Low Voltage Compartment:
1. Locate low voltage section behind separate door and physically isolated from medium voltage section.
2. Door to permit access to control logic without exposure to medium voltages.
3. Customer interlocking and control as well as metering, relays, and pilot devices shall be located in this section.
4. Optically isolate main control PC card located in low voltage section from medium voltage pulse generator cards on power poles.
5. Controller shall include 120 VAC test capability to power and adjust microprocessor control when isolating switch is in open position, with the following features:
   a. Test circuit shall consist of receptacle and plug mounted in low voltage compartment and accessible only when low voltage door is open.
   b. In test position, plug may be removed from receptacle and connected to external 120 V source of power.
   c. This shall isolate control transformer and prevent energizing control transformer secondary from test voltage source.

2.8 SOLID STATE STARTER LOGIC CONTROL

A. Starter shall be fully microprocessor controlled and operated. The logic control shall include the following:
1. Basic motor control algorithm shall be sensorless torque control, not closed loop current control. The sensorless torque control shall eliminate torque surge as the motor approaches full speed and limit water hammering due to pressure rise.
2. Redi View™ Commissioning/Monitoring software.

3. Embedded Devicenet™ for communications purposes.
4. RS232 and RS485 communications ports.
5. 8-bit, 20MHz processor, Minimum.

B. Provide a door mounted Display & User Interface Module with the following functions:
1. Backlit LCD- 2 Lines, 16 Characters
2. Tactile Feedback Buttons
3. Pass Code Protection
4. Built in Start/Stop Pushbuttons
5. Real Time Status Indication via LCD Display and LED's
6. Scrolling Menu/Set Parameters
7. Discrete Enter Command Button
8. Meter Mode Display
9. Selectable Meter Mode Scroll Rate
10. Main Display Hot Key
11. RediView™ Commissioning/Monitoring Software

C. Provide a Windows™ based software package with the Solid State Starters included under this contract for use on an owner furnished IBM compatible PC.The software shall be utilized to program and monitor the starter parameters listed in paragraphs C-I without exception. The software shall be provided now to accommodate future upgrades that may not part of this contract. The software shall include the following features and functions:
1. Connect to Starters via RS485Modbus or DeviceNet
2. Display up to eight (8) starters at a time as screen Icons
3. Provide realtime starter basic parameter feedback
4. Provide realtime Start and Stop capabilities
5. Provide realtime current trending chart display for each starter
6. Provide capability for full Starter parameter programming
7. Provide an Event Recorder Display (100 most recent events)
8. Provide a Fault Recorder Display (100 most recent events)
9. Provide a comparison of Setup parameters to Last Start conditions
10. Comm speed of up to 9600 baud
11. Provide Realtime Clock
12. Provide battery/UPS back-up of starter parameters.
13. Master/Slave operation
14. Heatsink over temperature detector
15. LED Indications
    a. Power ON
    b. Micro Computer Fault
    c. SCR Gate Drive Power

d. Shorted SCR

D. Programmable Motor Control Functions
   1. Motor Starting/Running
      a. Programmable Current Ramp
      b. Ramp to Limit
      c. Full Voltage Start
      d. Initial Current Limit (50-400%)
      e. Start Ramp Time (0-120 Sec.)
      f. Maximum Current (100-600%)
      g. Dual Kick Start (0.1-10 Seconds)
      h. Dual Ramps
      i. Programmable 1-1200 Amps
      j. Motor Service Factor (1.0-1.99)
      k. Tach Feedback Linear Acceleration
      l. Tach Feedback Linear Decelaration
      m. Power Outage Ride Through
      n. Adjustable Current Transformer Ratio
   2. Motor Stopping
      a. Fully Programmable “S” Curve Pump Decel
      b. Tach Feedback Linear Deceleration
      c. Soft Stop
      d. Fail Soft on Motor Overload
      e. Auxiliary Motor Feeder Control
   3. Interlocking/Logic
      a. Restart Block-Backspin Timer
      b. Overload Lockout
      c. General Fault Digital Relay Output
      d. Assignable Digital Relay Outputs (2)
      e. Frequency Tracking
      f. Up to Speed Indication/Contact
      g. Preassigned Digital Inputs (7)
      h. Analog Input
      i. Tachometer Input
      j. User Selectable # of Auto Restarts
      k. User Selectable Fault Priority
      l. Fully Programmable 4 or 7 output Relay Cards
      m. Programmable "Ready" Contact
   4. Maintenance
      a. Emergency Restart After Fault Lockout
      b. Selectable CT Ratios
      c. Current Limited Jog

d. Built In Self Test: Provide built-in self testing capability to perform the following functions to verify satisfactory starter operation:
   (1) Sustained generation of SCR gate firing signals for 3 minutes to allow measurements to be made for the presence, amplitude and duration of the gating signals.
   (2) Engage the Bypass and Inline contactors at least 3 times, utilizing aux. contact feedback to the micro processor to verify correct operation of the contactors.
e. Real Text Event Recorder

E. Programmable Motor Protection Functions
   1. Motor/Machine Faults
      a. Electronic Overload
      b. Overload Reset
      c. Overload Warning
      d. Acceleration Timer
      e. Mechanical Jam/Electronic Shearpin (Selectable Trip or Warning)
      f. Motor Thermal Capacity Protection
      g. Undercurrent Alarm (Selectable Trip or Warning)
      h. Time Between Restarts
      i. Trip Reset Protection
      j. Machine Ground Fault Protection (Selectable Trip or Warning)
      k. Stalled Motor Detection
      l. Starts Per Hour Limiter
      m. Watt, Watt/Hour Limiter
   2. Electrical System Faults
      a. Undercurrent Protection
      b. Overcurrent Protection
      c. Current Unbalance (10-40%)
      d. Line Phase Loss Detection
      e. Undervolt Protection (10-30%)
      f. Overvolt Protection (10-30%)
      g. Phase Sequence Sensitivity/Insensitivity
      h. Phase Reversal Protection
      i. Underfrequency Protection
      j. Overfrequency Protection
      k. Solid State Overload Class 1 through Class 40
      l. Overload Alarm
      m. Line Frequency Tracking
      n. Generator Set Frequency Tracking
      o. Restart After Non-critical Fault

p. Ground Fault Protection
q. Instantaneous Overcurrent Protection
r. Voltage Unbalance

F. Diagnostics Functions
1. Alpha/Numeric Fault Display
2. Revolving 99 Most Recent Events
3. Start/Stop Recorder
4. Date & Time Stamped Events
5. Motor Thermal % Capacity Display
6. Closed Loop Motor Stall Detection
7. Open Loop Motor Stall Detection
8. Open Gate Detection
9. Starter Status Indication
10. Pre-Start: Pending Fault
11. Pre-Start: Phase Rotation
12. Control Board Built in Self Tests
13. Starter/System Level Built in Self Tests
14. Self Check Parameter Set-Up
15. LED Indication SCR Status
16. Full Screen Meter Mode

G. Metering Functions
1. Standard Meter Displays:
a. Scrolling Current
b. Average Current
c. Current, L1
d. Current, L2
e. Current L3
f. Scrolling Voltage
g. Average Voltage
h. Voltage, L1
i. Voltage, L2
j. Voltage, L3
k. Line Frequency (50-60Hz)
l. % Overload
m. Elapsed Time Meter
n. Elapsed Hour X100 Meter
o. Mega-Watt Hours
p. kVAR
q. kVA
r. Ground Fault Current

s. Starts Counter
t. Current Imbalance Percent
u. Power Factor

H. Programmable Relay Outputs
1. Standard Programmable Relay Outputs
a. Overload
b. Overload Lock
c. Overload Warn
d. Run
e. Up To Speed
f. Shorted SCR
g. Shunt Trip
h. Ground Fault
i. Shear Pin Trip
j. Under Current Trip
k. Ground Fault
l. Brake Mode
m. Starter Ready
n. Modbus Remote #1
o. Modbus Remote #2
p. Line Phase Loss
q. Line Phase Imbalance
r. Low Three Phase Line
s. Line Phase Sequence Change
t. Motor Thermal Overload Trip
u. Battery Backup Failure
v. Instantaneous Overcurrent
w. Shorted SCR Fault
x. Three Phase Line Frequency Deviation
y. Control Power Failure
z. Computer Error
aa. Up to Speed Fault
bb. High/Low Frequency Fault
2. Output relay contacts shall be rated 5 Amps inductive and 10 Amps resistive.

I. Programmable Analog Outputs: For Starters specified to be furnished with Modbus RTU communications capability, provide four (4) programmable analog outputs.

J. Passcode Protection: All parameters identified in paragraphs 2.07C through 2.07H shall be passcode protected.

2.9 MOTOR PROTECTION

A. Provide motor monitoring and protection features as described below. Listed motor protection functions shall be via a GE Multilin 869 with all requisite PT's and CT's.

B. RTD Monitoring, General
   1. 8 channels, programmable, expandable to 16 channels
   2. Meter display in C° or F°, +/- 1% of the following:
      a. Individual RTD temperatures
      b. Sample and hold
   3. Individual Alarm and Trip set points
   4. Remote monitoring capability with RS-485 communication to Starter

C. The following ANSI protective device functions shall be provided:
   1. 27/59 – Undervoltage and overvoltage
   2. 46 – Current unbalance
   3. 49R – Winding overtemperature (RTD)
   4. 50G – Ground instantaneous overcurrent
   5. 51G – Ground time overcurrent
   6. 50P – Phase instantaneous overcurrent
   7. 51P – Phase time overcurrent
   6. 62- Timer

D. Miscellaneous Functions
   1. Time between starts
   2. Broken RTD alarm
   3. Short/low RTD alarm
   4. Undervoltage alarm
   5. RS485 Modbus communications
   6. 99 time/date stamped event records

2.11 POWER BUS

A. Main Bus:
   1. Bus ratings shall be in accordance with UL 347.
   2. Tin plated copper with minimum ampacities per manufacturers standard for rated horsepower as indicated herein or as indicated on the drawings.
   3. Locate at top of enclosure. Mount in common front-to-back horizontal plane to provide optimum heat distribution.
   4. Protected against H2S exposure per Para. 1.02.E.3
   5. Support on 15 KV fiberglass polyester insulators.

B. Bracing:
   1. Brace and test bus bars and cables to withstand rated short circuits, without damage or deformation.
   2. Short circuit ratings shall be 80KAIC per NEMA/EEMAC and UL.
   3. Bolted bus joints shall have a minimum of two bolts. Provide suitable bolt holes to facilitate future extension of motor control center on either side.

C. Ground Bus: A continuous copper ground bus shall be provided along the entire length of the control line-up. The ground bus shall be 1/4" x 1" bare copper.

2.12 SHOP TESTS

A. Certified Shop Tests
   1. Shop testing shall be performed on the medium voltage solid state starter at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of NEMA and UL and shall demonstrate that the equipment tested conforms to the requirements specified.
      a. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.
      b. Medium voltage solid state starter shop tests shall include the following:
         1) Physical inspection shall be performed including torque tests of bus bolts.
         2) Mechanical operations shall be performed to insure proper functioning of operating mechanisms and interchangeability.
         3) Continuity test shall be performed on power and control wires.
         4) Applied potential test of all switch and starter busses
         5) Functional operations test which shall include pick up, dropout, time delay, sequence and polarity.
         6) Power cables and buses shall be tested, for insulation breakdown resistance and circuit isolation. Test voltage frequency shall not be less than the frequency of the rated voltage of the equipment tested.
   2. A dielectric test at the conclusion of the withstand and closing tests shall be performed.
   3. Temperature rise tests in accordance with UL 1008 shall have been conducted after the overload and endurance tests to confirm the ability of the units to carry their rated currents within the allowable temperature limits.
   4. The Solid State Starter manufacturer shall functionally test the starter at rated voltage and horsepower on an AC three phase induction motor (low voltage testing of medium voltage equipment will not be accepted).

5. The manufacturer must test and certify starting, stopping and logic interlock functionality.
6. The manufacturer shall load test the starter at rated current (including the service factor rating) at three phase low voltage for a minimum of eight hours (or until the temperature rise of the hottest measured point stabilizes to less than 2% change for ten minutes).
7. The starter manufacturer must be U.L. load test.
8. The starter manufacturer shall submit a certified factory shop test report for approval certifying that the starter has met the design requirements of the specification.
9. All incoming material shall be inspected and/or tested for conformance to quality assurance specifications
10. Power semiconductors shall be fully tested for proper electrical characteristics, including dv/dt and di/dt.
11. All subassemblies shall be inspected and/or tested for conformance to quality assurance specifications.

B. Each completed unit shall be functionally tested prior to shipment to assure conformance to the specifications.

C. Witnessed Shop Tests:
   1. The Contractor shall perform witnessed shop tests in accordance with General Conditions Article GC-19.

   2. Shop testing shall be performed on the switchgear at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of ANSI and shall demonstrate that the equipment tested conforms to the requirements specified. All shop testing will be witness by three (3) County representatives.

   3. The Contractor shall include the cost for three (3) County representatives (airfare, food, hotel – one occupant per room, and transportation) to attend and witness all factory shop tests.

   4. Obtain approval of the testing procedure and test stand layout prior to scheduling a witness shop test.

   5. The Contractor shall provide a certified shop test report. The report shall identify the tests performed and the results obtained.

6. The Contractor shall submit and obtain acceptance by the Engineer of the witness shop test report prior to shipment of the equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
   1. The medium voltage solid state starters shall be furnished and installed as shown on the Drawings and in accordance with the manufacturer's installation instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment. The equipment shall be suitably protected until accepted by the Owner.
   2. The equipment shall be installed and checked in accordance with the manufacturer's recommendations. This shall include but not limited to:
      a. Checking to ensure that the pad location is level to within .125 inches if applicable.
      b. Checking to ensure that all power connections are torque to the manufacturer's recommendations.
   3. Secure assemblies to foundation on floor channels if applicable.
   4. Measure and record Megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four-wire systems only).
   5. Medium voltage solid state starters shall be fully assembled with all required devices, wiring, nameplates, terminal blocks and enclosures.

   6. Mount Medium voltage solid state starters rigidly and securely to the building structure or to supporting devices, which are rigidly and securely supported to the building structure.
   7. Medium voltage solid state starters shall be fastened to the structure in accordance with the structural and seismic requirements.
   8. Mount Medium voltage solid state starters with sides parallel or perpendicular to walls or equipment.
   9. Install all Medium voltage solid state starters such that door swing is not hampered.

B. Locations and Sizes
   1. Medium voltage solid state starters locations shown on the Contract Drawings are approximate. Sizes shall be as dimensioned on the Contract Drawings, or, if not specifically dimensioned, as required to house all devices, terminal blocks and conduits which enter the enclosure.

2. All Medium voltage solid state starters sizes and locations shall be submitted by the Contractor for the Engineer's approval.

C. Grounding
   1. All Medium voltage solid state starters shall be grounded in accordance with NEC requirements.
   2. The use of two (2) locknuts and a grounding bushing shall be required at all conduit terminations where hub type fittings are not required. Conduit grounding bushings within medium voltage solid state starter shall be bonded together with jumper cables where enclosure size or number of conduits warrants their use per NEC requirements.

D. Terminal Blocks
   1. Terminal blocks shall be installed parallel or perpendicular to the Medium voltage solid state starters enclosure sides. Approximately 20 percent spare terminals shall be provided (minimum of two (2). Terminals shall be lettered or numbered to conform to the wiring diagrams.

E. Wiring
   1. The wiring within the Medium voltage solid state starter shall be neatly harnessed to prevent the door damaging the wiring and to prevent the wiring from hampering the door operation.
   2. All conductors shall have identification markers on each end. Marker numbers shall match the terminal block numbers consistent with the Shop Drawings.

3.2 FIELD TESTS

A. After installation, Medium voltage solid state starters shall be field tested for operation and conformance. The Contractor shall perform field testing in accordance with the Specifications. The field tests shall be witnessed by the Engineer and certified by the Contractor.
B. Medium voltage solid state starters testing shall be performed by the manufacturer's representative, prior to energizing equipment. The testing shall be in accordance with the recommendations of the manufacturer's representative. Equipment shall not be energized without the permission of the Engineer.
C. Combination of starter with blower/motor shall be tested for system compatibility and to assure conformance to the Specifications for the motor driven equipment requirements.

3.3 MANUFACTURER'S FIELD SERVICES

A. A qualified manufacturer's representative shall assist in the installation of the medium voltage solid state starter, check the medium voltage solid state starter installation before it is placed into operation, assist in the performance of field tests, observe and assist initial operations and train the plant operations and maintenance staff in the care, operation and maintenance of the medium voltage solid state starter.

B. The Contractor shall provide equipment start-up services and training in accordance with the Specifications.

C. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction and all other pertinent information.

D. The service representative shall sign in with the Engineer on each day they are at the site.

E. Bid price shall include 15 visits, consisting of 5 consecutive days each, for startup and training.

F. Services shall include startup of equipment and field/classroom training for owner's personnel.

G. Startup and training shall be provided by factory direct personnel only. The use of agents, manufacturer's representatives, associated integrators or manufacturer's distributors for startup and training shall not be permitted.

3.4 ACCEPTANCE TESTING

A. The Contractor shall provide acceptance testing of the medium voltage solid state starter. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under Article 3.02. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

B. Acceptance testing inspection shall be performed on each switchgear. Inspection shall include the following:
   1. Physical, electrical and mechanical condition shall be inspected.
   2. Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.
   3. All connections shall be inspected for high resistance.

4. Electrical and mechanical interlock systems shall be checked for proper operation.
5. Insulators shall be inspected for evidence of damage or contamination.
6. Equipment shall be cleaned and lubricated as required.

C. Acceptance electrical testing shall be performed on each medium voltage solid state starter. Testing shall include the following:
1. Ground-resistance tests shall be performed.
2. Insulation-resistance tests shall be performed on each bus, phase-to-phase and phase-to-ground.
3. Test each pole with other poles grounded. An over potential test shall be performed.
4. Contact-resistance test shall be performed.
5. Control and metering wiring performance test shall be performed.

D. All tests and values shall be in accordance with the manufacturer's recommendations and NETA, ATS Acceptance Testing Specification.

E. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA, ATS Acceptance Testing Specification.

3.5 PAINTING

A. After fabrication, bonderize, chemically clean and paint exterior and interior surfaces of the switchboard with a rust inhibiting primer followed by an ANSI 61 gray finish coat cathodic electro-deposition epoxy.

B. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

3.6 IDENTIFICATION

A. Each medium voltage solid state starter shall be identified with the identification number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each medium voltage solid state starter. Nameplates shall be as specified in Specification 16076 Labeling and Identification.

3.7 RUBBER MATS

A. Surface mats shall be of prime quality rubber compound, free of calendaring and curing defects and shall be resistant to weather, aging and ozone in normal concentrations. Mats shall be 5/8-inch thick and shall be custom made to sizes shown with beveled edges.

B. Floor mats shall be furnished and installed along the entire front of each switchgear furnished and installed under this Contract, i.e., a continuous run along the front of the Medium Voltage Metal-Clad Switchgear.

C. Mat shall be black with yellow safety stripe on edge as manufactured by American Floor Mats, series double-duty anti-fatigue mats.

3.8 WARRANTY

A. Starters furnished herein shall include a three (3) year manufacturer's warranty (from date of acceptance by the owner) on all solid state power sections and P.C. solid state control cards with one (1) year manufacturer's warranty (from date of acceptance by the owner) on other equipment of each system. Solid state starter manufacturer shall guarantee in writing, availability of parts, service and technical support for said product for a minimum of 7 years.

3.9 FACTORY SERVICE

A. Factory support must be provided by the original equipment manufacturer 365 days a year, 24 hours a day.

B. Factory support and service must be provided by manufacturer's trained technicians. At the customer's request verification of the technician's qualifications must be provided for record.

+ + END OF SECTION + +

SECTION 16322

CAST COIL TRANSFORMERS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Cast Coil Transformers shall be provided in accordance with the requirements specified under this section, the Specifications, and the Contract Drawings.

B. The Contractor shall furnish, install, test and place into satisfactory operation cast coil transformers as shown on the Contract Drawings and specified herein.

1.2 RELATED SPECIFICATIONS

A. Specification 16076 - Labeling and Identification

B. Specification 16292 – Power Distribution System Coordination

C. Specification 09900 - Painting

1.3 PAYMENT

A. Payment for Cast Coil Transformers shall be made as provided for in the Specifications.

1.4 REFERENCES

A. Transformers shall comply with the latest applicable provisions and recommendations of the following:

1. NFPA 70, National Electrical Code

2. ANSI C57.12.01 - Standard General Requirements for Dry-Type Distribution and Power Transformers

3. ANSI C57.12.70 - Terminal Marking and Connections

4. NEMA TR1, Transformers, Regulators and Reactors

5. ANSI Standard (37.12, General Requirements for Distribution, Power, and Regulating Transformers

6. ANSI Standard C57.12.51, Ventilated Dry-Type Power Transformers

7. ANSI Standard C57.12.91 Test Code for Dry-Type Power Transformer

8. ANSI Standard 257.94, Installation and Maintenance of Dry-Type Power Transformers

9. NETA, International Electrical Testing Association

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:

1. Manufacturer's technical information which shall include:

   a. Dimensional information
   b. Equipment cross sections
   c. Three-line diagrams
   d. Technical specifications
   e. Catalog cuts
   f. Complete transformer data and performance characteristics including nameplate data sheet
   g. Weights of all component parts, assembled weight of units and approximate total shipping weight
   h. Construction details of enclosures
   i. Interconnection Wiring Diagrams
   j. Painting procedures
   k. Preliminary operation and maintenance manuals

C. Testing Methods

1. Description of shop and field testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least 45 days in advance prior to conformation of witness testing dates and actual testing.

2. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least 45 days in advance to actual testing, five recent references with phone numbers shall be submitted

3. Transformer anchorage details with design calculations signed by licensed

Engineer.

4. Elementary Diagrams and Interconnecting Wiring Diagrams having their terminals identified and indicating the internal wiring and all control and test switch developments. Common Elementary and Interconnection Wiring Diagrams shall not be acceptable. Separate drawings for each equipment shall be supplied. Wire lists in lieu of wiring diagrams shall not be acceptable. Separate drawings for each compartment shall be supplied including individual compartment point-to-point wiring diagrams.

5. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the equipment furnished under this section for a period of one (1) year after acceptance. Replace all lubricants used during startup and testing prior to acceptance of equipment. Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

D. Certificates of Compliance

1. Seismic qualification certification from the manufacturer including mounting recommendations.

2. Data and results of witness tests accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed.

E. Reports

1. Shop test and field test reports shall be submitted

2. Manufacturer's site visit and acceptance testing reports shall be submitted

3. Operation and maintenance manuals shall be submitted in accordance with the Specifications

1.6 QUALITY ASSURANCE

A. System Requirements

1. Transformers shall be designed, built, and tested in accordance with the latest applicable editions of ANSI/IEEE, NEMA, UL, NFPA and NFPA 70 National Electrical Code.

2. Transformers shall be constructed as service equipment in accordance with the requirements of NFPA 70 National Electrical Code.

3. All structures shall be fabricated of code gauge steel. Steel surfaces shall be chemically cleaned, treated and finished with ANSI No. 61 indoor light grey paint.

4. The transformer manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all factory tests. Calibration of testing apparatus shall be within one year.

5. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology and the NETA acceptance testing specification.

6. Contractor shall retain the service of an independent testing firm to perform the Power Distribution System Coordination studies as specified in Section 16292. The testing firm shall have experience in the inspection and testing of the system equipment and shall be a member company of NETA. Provide proof of membership or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer.

B. Seismic Requirements:

1. The transformer shall be designed, constructed, and installed suitable for earthquake regulations in accordance with the seismic requirements of the New York State Building Code and the Uniform Building Code for zone 2A application with the requirements specified under Article 3.01.

2. The services of the substation manufacturer shall be retained for field service. Field service shall be in accordance with the requirements specified under Article 3.04.

3. Retain the service of an independent testing firm who shall perform field acceptance testing of the transformers. The testing firm shall have experience in the inspection and testing of transformer equipment and shall be a member company of NETA. Provide proof of membership, or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer. Acceptance testing shall be in accordance with the requirements specified under Article 3.05.

1.7 DELIVERY, STORAGE AND HANDLING

A. Transformer equipment shall be delivered, stored, and handled in accordance with the Specifications and the manufacturer's instructions.

B. Field:

1. Transformer equipment shall be inspected for shipping damage or loose parts when received. Evidence of water which may have entered equipment during transit shall be checked.

2. Transformer equipment shall be lifted, rolled, or jacked into locations shown on the Contract Drawings. Switchgear shall be handled in place without circuit breakers.

3. Transformer equipment shall be stored in a clean, dry location in which a uniform temperature is maintained. Equipment shall be protected with coverings and maintain air circulation.

4. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.

1.8 SPARE PARTS

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the transformers in accordance with Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts shall be furnished in accordance with the manufacturer's recommendations. Spare parts for each transformer shall include at a minimum the following:

1. Two (2) complete cooling fans with motors.

2. One (1) protective device and gauge of each type provided.

3. All manufacturer recommended spare parts.

4. Six sets of three phase CT arrangements.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Transformers shall be manufactured by:
1. ABB

2. Square D
3. Eaton

2.2 TRANSFORMERS

A. The transformers shall be solid-cast dry-type construction designed for the following:

1. For TR-A4/TR-B4
   a. Rating: 2,000 kVA (AA/FA)
   b. Winding Temperature Rise 115°C/115°C
   c. High Voltage 4,160Δ V
   d. H.V. BIL 60 kV
   e. Low Voltage 480Y/277 V
   f. L.V. BIL 30 kV
   g. Minimum Efficiency 99%
   h. Impedance 5.75%
   i. Frequency 60 Hertz
   j. Enclosure NEMA 3R

B. Transformer winding construction shall be in accordance with the following:

1. Epoxy resin shall be rated 185 degrees C used throughout construction. The electrical insulation system shall utilize class F material in a fully rated 185C system. Transformer design temperature rise shall be based on a 30°C average ambient over a 24-hour period with a maximum of 40°C. Solid insulation in the transformer shall consist of inorganic materials such as glass fiber, electrical grade epoxy and Nomex. All insulating materials must be rated for continuous 185°C duty

2. Cores shall be silicon steel construction assembled and rigidly clasped to ensure mechanical strength and to reduce vibration. Core shall be grounded to the frame with a flexible grounding strap.

3. High and low voltage windings shall be copper and have high dielectric and mechanical strength insulation. Coils shall be sized, insulated, and supported for short circuit forces and be impervious to moisture. The windings shall withstand impulse, induced and dielectric test voltage and short circuit testing without damage.

4. For enhanced environmental protection and improved withstand ability to thermal shock and short-circuit stresses, the primary and secondary coil assemblies shall be of cast coil design. Each cast coil shall be cast under vacuum in a mold to assure complete, void-free epoxy resin impregnation

throughout the entire insulation system.

5. The high voltage primary windings shall be disc wound for enhanced voltage stress distribution and to facilitate complete epoxy penetration. The high voltage primary windings shall be completely impregnated and cast in epoxy resin under vacuum in molds and be oven cured.

6. The low voltage secondary winding shall be resin encapsulated by winding epoxy-impregnated insulation. All exposed surfaces shall be covered and sealed with epoxy. The entire winding shall be oven cured.

C. Transformers shall be equipped with ten 2-1/2 percent fully rated taps. Taps shall include four 2-1/2 percent primary taps above normal and six-2-1/2 percent primary taps below normal. Easily accessible bolted tap links in the high-voltage windings shall be changed when the transformer is deenergized.

D. Transformer enclosure shall be grounded heavy gauge sheet steel. The transformer enclosure shall include ventilation louvers, removable panels for access to tape, and vibration isolating pads. Each enclosure shall be equipped with a diagrammatic nameplate.

E. All Transformer components shall be suitable for the forced air rating. The transformers shall contain all necessary components and wiring, including fans, for automatically increasing the kVA rating by at least 25%. The (FA) package shall include an electronic temperature monitor and fan control unit. The temperature monitor and fan control shall include digital readout, GREEN -- power on, YELLOW – fan on, RED -- high temperature indicating lights; audible high temperature alarm with alarm silence push button; maximum temperature memory with read and reset switch; auto/manual fan control switch, system test switch; temperature sensing in all three (3) low-voltage coils. Auxiliary alarm contact and means for remote control and temperature monitoring shall be provided. Control power shall be provided from a separate, external control power source.

F. Forced air cooling equipment shall be provided. The air cooling equipment shall increase the transformers output rating 33.33 percent and shall include:

1. Cooling fans shall provide air cooling of windings.

2. Temperature probes embedded in the windings shall provide sensing of temperature.

3. Fused control power transformer shall provide supply of cooling fans and control unit.

4. Electronic control unit with digital display shall provide monitoring and control of the transformers. The control shall permit manual and automatic operation of the fans and temperature readings of the windings.

5. Hardware necessary for mounting air cooling equipment shall be provided within the enclosure.

G. The transformer enclosure shall have high voltage signs in accordance with the requirement of General Specification 16076 – Labeling and Identification.

H. The transformer shall be designed to meet the sound level standards for dry transformers as defined in NEMA TR1.

I. Cast coil transformers shall include thermostatically controlled space heaters fed from external source which remains energized when the transformer is de-energized. Provide special ventilating grills that restrict the passage of rain or spray providing the degree of weather protection of a NEMA 3R enclosure.

2.3 ACCESSORIES

A. Transformer features and accessories shall include:
1. Removable case for access to high-voltage strap-type connector taps for de-energized tap changing.
2. Provisions for lifting and provisions for jacking.
3. Two (2) ground pads.
4. Instruction nameplate.

2.4 TERMINAL COMPARTMENTS

A. The transformer unit supplied shall include low voltage terminal compartments. Connections to and from the low voltage (secondary) side of the transformer shall be by cable and terminations shall be made in the terminal compartment.

B. Connections from the load side of the associated medium voltage switch and the high voltage (primary) side of the transformer shall be bus connections.

C. The control and auxiliary power circuits shall be completely wired to a NEMA 4X stainless steel enclosure. Enclosure shall have hinged door and shall house all terminal blocks, auxiliary relays, cooling fan controls, etc.

2.5 CONTROLS

A. The manufacturer shall furnish and install all relays, cooling fan controls,

gauges, current transformers, etc. and all related wiring as shown on the Contract Drawings, specified herein and as required for proper operation.

B. All control and auxiliary wiring shall be #10 AWG minimum and shall be terminated in the control enclosure described in 2.04.B above. Cables and wires shall be routed in rigid steel conduit. Provide flexible conduit where required.

C. All wiring terminations shall be identified by legible markings on the device terminals. In addition, all wiring terminations shall be identified by permanent wiring jacket or wiring sleeves. Adhesive wire labels are not permitted. Each relay, fuse block, terminal block or other auxiliary device shall be permanently labeled to coincide with shop drawings, using 1"x 2" lamicoid nameplates.

D. The controls shall have all the remote contacts required for interconnection to switchgear, as shown on the Contract Drawings. All contacts shall be wired to terminal strips within the control enclosure, per ANSI C57.12.70.

2.6 PAINTING

A. All metal surfaces of the transformers shall be thoroughly cleaned and given one coat of zinc chromate primer. All interior surfaces shall then be given one shop finishing coat of a nitro-cellulose lacquer enamel.

B. All exterior surfaces shall be given three coats of the same lacquer. The color of the finishing coats shall be light gray ANSI No. 61.

2.7 SHOP TESTS

A. Certified and Witness Shop Tests:

1. Shop testing shall be performed on the transformers at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of ANSI and shall demonstrate that the equipment tested conforms to the requirements specified. All shop testing will be witness by three (3) County representatives.

2. The Contractor shall include the cost for three (3) County representatives (airfare, food, hotel, and transportation) to attend and witness all factory shop tests.

3. The Contractor shall provide a certified shop test report. The report shall identify the tests performed and the results obtained.

4. All transformer tests shall be in accordance with ANSI C57.12.01 and .91 and NEMA TR1. Transformer shop tests shall include the following:

    a. Resistance measurements of all windings shall be performed on the rated voltage connection.
    b. Ratio test on the rated voltage connection and on all tap connections shall be performed.
    c. Polarity and phase relation tests on the rated voltage connection shall be performed.
    d. No load loss at rated voltage on the rated voltage connection shall be performed
    e. Excitation current at rated voltage on the rated voltage connection shall be performed.
    f. Impedance and load loss at rated current on the rated voltage connection shall be performed.
    g. Applied potential tests shall be performed.
    h. Induced potential test shall be performed.
    i. High potential test shall be performed.
    j. Temperature rise tests shall be made on each transformer at the 80/115C rating in accordance with ANSI C57.12.00. This test shall be performed on the transformer prior to impulse tests. Temperature test(s) shall be made on each transformer. When a transformer is supplied with auxiliary cooling equipment to provide more than one kVA rating, temperature test as listed above shall be made on the lowest kVA, AA rating and the highest kVA FA rating.
    k. Operational test on auxiliary devices and wiring.
    l. Insulation test on auxiliary devices and wiring.

5. Test equipment to demonstrate that it has been properly assembled, properly lubricated, is not overheating, is not overloading, and has no electrical or mechanical defects.

6. Perform all certified shop test and submit the shop test reports prior to scheduling the witness shop test.

B. Witnessed Shop Tests:
    1. The Contractor shall perform witnessed shop tests in accordance with General Conditions Article GC-19.

    2. Shop testing shall be performed on the switchgear at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of ANSI and shall demonstrate that the equipment tested conforms to the requirements specified. All shop testing will be witness by three (3) County representatives.

3. The Contractor shall include the cost for three (3) County representatives (airfare, food, hotel – one occupant per room, and transportation) to attend and witness all factory shop tests.

4. The Contractor shall provide a certified shop test report. The report shall identify the tests performed and the results obtained.

5. Obtain approval of the testing procedure and test stand layout prior to scheduling a witness shop test.

6. The Contractor shall submit and obtain acceptance by the Engineer of the witness shop test report prior to shipment of the equipment.

2.8 RUBBER MATS

A. Contractor shall furnish and install floor mats. Floor mats shall be of prime quality rubber compound, free of calendering and curing defects and shall be resistant to weather, aging and ozone in normal concentrations. Mats shall be 5/8-inch thick and shall be custom made to sizes shown with beveled edges.

B. Floor mats shall be furnished and installed along the entire front, back and side of each transformer furnished and installed under this Contract.

C. Mat shall be black with yellow safety stripe on edge as manufactured by American Floor Mats, series double-duty anti-fatigue mats.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed in accordance with manufacturer's instructions and recommendations.

B. Equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. Steel channels shall be provided for support of equipment. Equipment shall be securely mounted to surface with anchor bolts. Anchor transformer to satisfy the specified seismic requirements of equipment.

D. The Contractor shall follow manufacturer’s instructions as to lifting requirements and attachment to structure.

E. The Contractor shall interconnect and wire all equipment per Contract Drawings

and as required.

F. The Contractor shall test and adjust all equipment for the transformer. All devices shall be properly adjusted such that all protection and control circuits operate correctly and safely.

G. Install transformer nameplates for identification of equipment as identified per Specification 16076, Labeling and Identification.

H. Control wiring shall be identified per Specification 16076, Labeling and Identification.

3.2 GROUNDING

A. The transformers shall be properly grounded per NEC requirements and as shown on the Contract Drawings.

3.3 FIELD TESTS

A. After installation, transformers shall be field tested for operation and performance. The Contractor shall perform field testing in accordance with Specifications. The field tests shall be witnessed by the Engineer and certified by the Contractor

B. Transformer testing shall be performed by the manufacturer's representative, prior to energizing equipment. The testing shall be in accordance with the recommendations of the manufacturer's representative. Equipment shall not be energized without the permission of the Engineer.

C. Test the equipment to demonstrate the following:
   1. Equipment has not been damaged in transportation and installation.
   2. Equipment has been properly installed.
   3. Equipment has been properly lubricated.
   4. Equipment has been properly connected.
   5. Equipment is not overheating.
   6. Equipment is not overloading any part.
   7. The equipment has no electrical or mechanical defects.
   8. Compliance with performance and design parameters.
   9. System operability under all control schemes.

3.4 MANUFACTURER'S FIELD SERVICES

A. A qualified manufacturer's representative shall assist in the installation of the transformers, check the transformers installation before it is placed into

operation, assist in the performance of field tests, observe and assist initial operations and train the plant operations and maintenance staff in the care, operation and maintenance of the transformers.

B. The Contractor shall provide equipment start-up services and training in accordance with the Specifications. The Contractor shall provide the services of the representative for the following minimum durations:
   1. Equipment Installation and Inspection 4 visits of 1 day each.
   2. Field Tests 4 visits of 2 days each.
   3. Initial Operation 1 visit of 5 days each.
   4. Training 1visit of 3 days each.

C. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.

D. The service representative shall sign in with the Engineer on each day they are at the site.

3.5 ACCEPTANCE TESTING

A. The Contractor shall provide acceptance testing of the substation. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under Article 3.3. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

B. Acceptance testing inspection shall be performed on each substation. Inspection shall include the following:

   1. Physical, electrical, and mechanical condition shall be inspected.

   2. Proper anchorage required area clearances, physical damage and proper alignment shall be checked.

   3. All connections shall be inspected for high resistance.

   4. Insulators shall be inspected for evidence of damage or contamination.

   5. Equipment shall be cleaned and lubricated as required.

C. All tests and values shall be in accordance with the manufacturer's recommendations and NETA, ATS Acceptance Testing Specification.

D. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA, ATS Acceptance Testing Specification.

+ + END OF SECTION + +

SECTION 16430

LOW VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing low voltage switchgear. Low voltage switchgear shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

1.2 RELATED SPECIFICATIONS

A. Specification 16036 – Testing

B. Specification 16076 – Labeling and Identification

1.3 PAYMENT

A. Payment for low voltage switchgear shall he made as provided for in the Specifications.

1.4 REFERENCES

A. Low voltage switchgear shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. ANSI C37.20, Switchgear Assemblies.
   3. NEMA SG-5, Power Switchgear Assemblies.
   4. ANSI C37.13, Low-Voltage AC Power Circuit Breakers.
   5. ANSI C37.16, Preferred Ratings for Low Voltage Power Circuit Breakers.
   6. NEMA SG-3, Low-Voltage Power Circuit Breakers.
   7. NETA, International Electrical Testing Association

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Manufacturer's technical information which shall include:
      a. Dimensional information.
      b. Three-Line diagrams.
      c. Technical specifications.
      d. Catalog cuts.
      e. Construction details of enclosures
   2. Description of shop and field testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least 45 days in advance prior to conformation of witness testing dates and actual testing.
   3. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least 45 days in advance of actual testing, five recent references with phone numbers shall be submitted.
   4. Switchgear anchorage details with design calculations signed by licensed Engineer.

C. Certificates of Compliance:
   1. Seismic qualification certificate from the manufacturer including mounting recommendations.
   2. Data and results of witness tests accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed.

D. Reports

   1. Shop test and field test reports shall be submitted.
   2. Manufacturer’s site visit and acceptance testing reports shall be submitted.

E. Operation and maintenance manuals shall be submitted in accordance with the Specifications.

1.6 QUALITY ASSURANCE

A. General:
   1. Low voltage switchgear shall be designed, built and tested in accordance with the latest applicable editions of ANSI/IEEE, NEMA, UL, NFPA and the National Electrical Code.
   2. Low voltage switchgear shall be constructed as service equipment in accordance with the requirements of the National Electrical Code. It shall be the responsibility of the Contractor to submit all applicable drawings to the Commissioner.
   3. The costs of the drawing submission and any resubmissions shall be included for payment in the lump sum price bid for the work under this contract.
   4. All structures shall be fabricated of code gauge steel. Steel surfaces shall be chemically cleaned, treated and finished with ANSI No. 61 indoor light grey paint.
   5. The low voltage switchgear manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians for all factory tests. Calibration of testing apparatus shall be within one year.
   6. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology and the NETA acceptance testing specification.

B. Seismic Requirements:
   1. The switchgear shall be designed, constructed and installed suitable for earthquake regulations in accordance with the seismic requirements of the Nassau County Building Code and the Uniform Building Code for Zone 2A application.

C. Field Tests:

   1. The low voltage switchgear shall be field tested. Field testing shall be performed in accordance with the requirements specified under article 3.02.
   2. The services of the low voltage switchgear manufacturer shall be retained for field service. Field service shall be in accordance with the requirements specified under Article 3-03.
   3. Retain the service of an independent testing firm who shall perform field acceptance testing of the low voltage switchgear. The testing firm shall have experience in the inspection and testing of the equipment and shall be a member company of NETA. Provide proof of membership, or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer. Acceptance testing shall be in accordance with the requirements requirements specified under Article 3.4.

1.7 DELIVERY, STORAGE AND HANDLING

A. Switchgear equipment shall be delivered, stored and handled in accordance with the Specifications, the manufacturer's instructions and the following:

1. Switchgear equipment shall be inspected for shipping damage or loose parts when received. Evidence of water which may have entered equipment during transit shall be checked.
2. Switchgear equipment shall be lifted, rolled or jacked into locations shown on the Contract Drawings. Switchgear shall be handled in place without circuit breakers.
3. Switchgear equipment shall be stored in a clean, dry location in which a uniform temperature is maintained. Equipment shall be protected with coverings and maintain air circulation.
4. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.

1.8 SPARE PARTS

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the switchgear in accordance with the Specifications.

B. The spare parts shall be listed in the index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts shall be furnished in accordance with the manufacturer's recommendations. Spare parts for each switchgear shall include at a minimum, the following:

1. Feeder breakers shall be provided in the quantities and sizes as indicated on the Contract Drawings.
2. One set of power fuses shall be provided for each size and type used.
3. Two sets of control power fuses shall be provided for each type and size used.
4. Two per ten pilot lights shall be provided for each type used.
5. One spare key shall be provided for each interlock system.
6. Breaker lifting device suitable for top mounting on switchgear shall be provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Switchgear equipment shall be manufactured by Eaton, ABB, Square D or approved equal.

2.2 SWITCHGEAR

A. The low voltage switchgear shall consist of individually mounted power air circuit breakers in draw out type construction and auxiliary transition compartments.

B. The circuit breaker quantities and function and arrangement of the switchgear shall be as shown on the Contract Drawings. The switchgear shall be in accordance with the National Electrical Code. The low voltage switchgear ratings shall be in accordance with the following:

1. 600 volt, 3 phase, 60 Hertz.
2. Continuous AC main bus ampacity, bracing and number of wires and breaker interrupting ratings shall be as shown on the Contract Drawings.

C. The low voltage switchgear power bus shall be three phase tin-plated copper The bus system shall be in accordance with the following:
1. The main and vertical buses shall be phase and ground isolated and insulated from each other. Bus sizing and insulation shall be in accordance with the National Electrical Code.
2. Each circuit shall consist of the necessary bus connection between the section bus and the breaker line side stabs. Load studs shall be equipped with load extension buses terminating in bolted type terminals in the rear cable compartment.
3. The ground bus shall be tin-plated copper with current capacity equal to 1/2 capacity of main power bus and drilled with lugs of appropriate capacity.

D. The low voltage switchgear shall be of a self-contained and self-supported structure having individual breaker or instrument compartments, transition compartments, a centralized bus compartment and a rear cabling compartment. The switchgear structure shall be in accordance with the following:
1. The rear cable compartment shall be segregated from the bus sections by means of solid insulating barriers. Rear compartments shall be equipped with hinged access doors.
2. Each individual breaker compartment shall be completely segregated from adjacent compartments by means of barriers at rear, top, bottom and sides. It shall be equipped with draw out rails, levering out mechanism and primary and secondary contacts.
3. The feeder circuit breakers shall be arranged for termination of steel conduit and copper fable feeders. Crimp type terminals, suitable for cables furnished shall be provided for all cable terminations. The number of conduits and cables associated with each feeder shall be in accordance with the conduit and cable schedule.
4. Where specifically shown on the Contract Drawings or stated in the Specifications, interlock systems shall be provided. The interlock systems shall be complete with all necessary keys and locks required for the operation shown or specified.

E. The switchgear shall include low voltage power circuit breakers, 3 pole, draw out type and shall include an electronic microprocessor based trip system. Breaker frame size and sensor rating shall be indicated on the Contract Drawings. Switchgear breakers shall be in accordance with the following:
   1. Each circuit breaker shall be UL listed for 100 percent continuous ampere rating when operating within the switchgear compartment.
   2. Each circuit shall be a manually operated stored energy mechanism unless electric operation is required. Where specifically shown on the Contract Drawings or stated in the Specifications, electrically operated breakers shall be provided. Electrically operated breakers shall be complete with 120 volt operators, open/close push buttons and control switch.
   3. The breaker removable elements shall be equipped with the disconnecting contacts, wheels and interlocks for draw out operation. The draw out design shall permit closure of the compartment door with the breaker in the "connected", " test" and "disconnected" positions. A mechanical interlock shall prevent breaker racking while in the closed position. The withdrawn position shall allow 180 degree unit rotation and provisions for padlocking shall be made for all positions.
   4. The electronic trip system shall include a plug-in protection programmer, a flux shift trip device and current sensor package. The programmer, sensor and flux-shifting trip device shall be constructed as integral elements of the breaker, requiring no externally mounted assemblies for proper operation.

   5. The protection programmer shall be solid state, microprocessor based, nine function type and shall provide true RMS current sensing. Where specifically shown on the Contract Drawings or stated in the Specifications, the programmers shall be equipped with electronic monitoring and communication circuitry. The programmer shall be in accordance with the following:
      a. The programmer's protective functions shall include adjustable continuous and instantaneous current elements with adjustable long time, short time, and zero sequence ground fault pickup and delay. For each of the main and tie circuit breakers, the instantaneous functions shall be omitted and the trip unit shall include a discriminator circuit to prevent the breaker from being closed and latched into a fault. The discriminator circuit shall have the capability of being disabled from a dial on the front of the unit.
      b. The programmer's monitoring and communication circuitry shall include communications, control and energy monitoring features, to permit both local and remote interface with the breakers circuits from the breaker interface module at the switchgear and the personal computer terminal in the control room.
      c. The protective, monitoring and communication type programmers shall provide complete communications and energy monitoring functions and be capable of passing the following minimum information to the breaker interface module and personal computer:
         1) Harmonic connection and percent THD.

2) Wave form analysis.
3) Energy consumption plus MVA and VAR.

6. Circuit breaker accessories shall include the following:
   a. Closing handle shall be provided for maintenance.
   b. Indicating lights shall be provided for circuit breaker status - red for "CLOSE", and green for "OPEN".
   c. Auxiliary contacts shall be provided for remote indication of circuit breaker status-open, close.
   d. Indicators shall be provided for overload, short circuit, and ground trip indication.
   e. Hand-held programmer shall be provided for accessing, displaying, configuring and testing each breaker trip unit.

F. Low voltage switchgear accessories shall be provided in accordance with the following:
   1. The switchgear shall include a 120 volt source suitable for operation as required of circuit breakers, meters and status lights. The 120 volt source shall be derived from two control power transformers, line side connected, and a transfer control. The transfer control shall include contactors to automatically switch from either control power transformer should a given supply be lost. The 120 volt source shall be distributed to the switchgear devices from a circuit breaker panel board which shall provide protection for the circuits.

   2. Where specifically shown on the Contract Drawings or stated in the Specifications, the switchgear shall include bus metering. The bus metering shall consist of three current transformers, ampere ratio as shown on the Contract Drawings, and a microprocessor based meter device. The meter device shall include self-contained potential transformers and internal fuses, and shall include the following direct reading metered values:
      a. AC ampere, each phase
      b. AC voltage, phase to phase and phase to neutral
      c. Watts, VARS and VA
      d. Watt-hours, VAR-hours and VA hours
      e. Power factor
      f. Frequency
      g. Percent THD
   3. Where specifically shown on the Contract Drawings or stated in the Specifications, the switchgear shall include an electronic interface module. The module shall permit central monitoring and display of each circuit breaker programmer parameters. The module shall also communicate information from the protective and energy monitoring type programmers over a monitoring network to a remote personal computer. The module shall permit configuration, display and testing features and shall include the following displayed parameters.
      a. Phase and average demand current
      b. Present and peak demand watts

c. Energy
d. Trip information
e. Percent THD
f. Percent harmonic content.

4. The switchgear control wire shall be Type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short circuit terminal blocks before connecting to any other device.
5. The switchgear shall have identifying nameplates in accordance with the requirements of Specification 16076 - Labeling and Identification. A switchgear master nameplate shall also be provided mounted on the assembly. The master nameplate shall identify switchgear designation, voltage, ampere and short circuit rating, manufacturer's name, general order number and item number.
6. Where specifically shown on the Contract Drawings, the switchgear shall be equipped with pull fuse disconnects for the auxiliary supplies noted. The disconnects shall be of the current interrupt disconnect block type with a fuse holder section in removable pull out head. The fused disconnect shall be rated 600 Volt, 30 Amp and shall include current limiting fuses with a withstand rating of 200,000 RMS Symmetrical amperes.

2.3 PAINTING

A. All metal surfaces of the switchgear shall be thoroughly cleaned and given one coat of zinc chromate primer. All interior surfaces shall then be given one shop finishing coat of a nitro-cellulose lacquer enamel.

B. All exterior surfaces shall be given three coats of the same lacquer. The color of the finishing coats shall be light gray ANSI No. 61.

2.4 RUBBER MATS

A. Contractor shall furnish and install floor mats. Floor mats shall be of prime quality rubber compound, free of calendering and curing defects and shall be resistant to weather, aging and ozone in normal concentrations. Mats shall be 5/8-inch thick and shall be custom made to sizes shown with beveled edges.

B. Floor mats shall be furnished and installed along the entire front, back and side of each transformer furnished and installed under this Contract.

C. Mat shall be black with yellow safety stripe on edge as manufactured by American Floor Mats, series double-duty anti-fatigue mats.

2.5 SHOP TESTS

A. Certified Shop Tests:
   1. Shop testing shall be performed on the switchgear at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of ANSI and shall demonstrate that the equipment tested conforms to the requirements specified.
   2. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.
   3. Switchgear shop tests shall include the following:
      a. Physical inspection shall be performed including torque tests of bus bolts.
      b. Mechanical operations shall be performed to insure proper functioning of operating mechanisms and interchangeability.
      c. Continuity test shall be performed on power and control wires.
      d. Functional operations test which shall include pick up, dropout, time delay, sequence and polarity.
      e. Primary hi-potential tests shall be performed. Primary current carrying parts shall be tested between phases, phase to ground, and line to load.
      f. The applied voltage shall be twice rated voltage plus 1000 for 1 minute.
      g. Hi-Potential tests on control and secondary wiring shall be performed. Control circuit wiring shall be tested for 1500 volts to ground for 1 minute.
      h. Power cables and buses shall be tested, for insulation breakdown resistance and circuit isolation. Test voltage frequency shall not be less than the frequency of the rated voltage of the equipment tested.

B. Witnessed Shop Tests:

1. The Contractor shall perform witnessed shop tests in accordance with General Conditions Article GC-19.

2. Shop testing shall be performed on the switchgear at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of ANSI and shall demonstrate that the equipment tested conforms to the requirements specified. All shop testing will be witness by three (3) County representatives.

3. The Contractor shall include the cost for three (3) County representatives (airfare, food, hotel – one occupant per room, and transportation) to attend and witness all factory shop tests.

4. The Contractor shall provide a certified shop test report. The report shall identify the tests performed and the results obtained.

5. Obtain approval of the testing procedure and test stand layout prior to scheduling a witness shop test.

6. The Contractor shall submit and obtain acceptance by the Engineer of the witness shop test report prior to shipment of the equipment.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed in accordance with manufacturer's instructions and recommendations.

B. Equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. Equipment shall be installed on concrete pads at locations shown on the Contract Drawings. Steel channels shall be provided for support of equipment. Equipment shall be securely mounted to surface with anchor bolts. Anchor switchgear to satisfy the specified seismic requirements in accordance with the anchorage details.

D. Install switchgear nameplates for identification of equipment.

3.2 FIELD TESTS

A. After installation, switchgear shall be field tested for operation and conformance. The Contractor shall perform field testing in accordance with the Specifications. The field tests shall be witnessed by the Engineer and certified by the Contractor

B. Switchgear testing shall be performed by the manufacturer's representative, prior to energizing equipment. The testing shall be in accordance with the recommendations of the manufacturer's representative. Equipment shall not be energized without the permission of the Engineer.

3.3 MANUFACTURER'S FIELD SERVICES IELD TESTS

A. A qualified manufacturer's representative shall assist in the installation of the switchgear, check the switchgear installation before it is placed into operation, assist in the performance of field tests, observe and assist initial operations and train the plant operations and maintenance staff in the care, operation and maintenance of the switchgear.

B. The Contractor shall provide equipment start-up services and training in accordance with the Specifications.

C. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule,

tasks performed, persons contacted, problems corrected, tests results, training, instruction and all other pertinent information.

D. The service representative shall sign in with the Engineer on each day they are at the site.

3.4 ACCEPTANCE TESTING

A. The Contractor shall provide acceptance testing of the switchgear. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under Article 3.2. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

B. Acceptance testing inspection shall be performed on each switchgear. Inspection shall include the following:
   1. Physical, electrical and mechanical condition shall be inspected.
   2. Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.
   3. All connections shall be inspected for high resistance.
   4. Electrical and mechanical interlock systems shall be checked for proper operation.
   5. Insulators shall be inspected for evidence of damage or contamination.
   6. Equipment shall be cleaned and lubricated as required.

C. Acceptance electrical testing shall be performed on each switchgear. Testing shall include the following:
   1. Ground-resistance tests shall be performed.
   2. Insulation-resistance tests shall be performed on each bus section and circuit breaker, phase-to-phase and phase-to-ground.
   3. Test each pole with other poles grounded. An over potential test shall be performed.
   4. Contact-resistance test shall be performed.
   5. Control and metering wiring performance test shall be performed.
   6. Circuit breaker trip characteristics shall be determined by primary current injection.

D. All tests and values shall be in accordance with the manufacturer's recommendations and NETA, ATS Acceptance Testing Specification.

E. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA, ATS Acceptance Testing Specification.

+ + END OF SECTION + +

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SECTION 16441

PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing panelboards. Panelboards shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The panelboards shall include all power distribution, lighting, appliance and instrument panels.

1.2 RELATED SPECIFICATIONS

A. Specification 16036 - Testing
B. Specification 16076 - Labeling and Identification

1.3 PAYMENT

A. Payment for panelboards shall be made as provided for in the Specifications.

1.4 REFERENCES

A. Panelboards shall comply with the latest applicable provisions and recommendations of the following:
   1.
   2. NFPA 70, National Electrical Code.
   3. UL Standard No. 50, Enclosures for Electrical Equipment.
   4. UL Standard No. 67, Panelboards.
   5. UL Standard No. 489, Molded Case Circuit Breakers.
   6. UL Standard No. 943, Ground Fault Circuit Interrupters.
   7. NEMA PB1, Panelboards.
   8. NEMA AB1, Molded Case Circuit Breakers.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:

1. Manufacturer's technical information for the panelboards proposed for use including all components.
2. A listing of the panelboards with the number and size of circuit breakers identified.
3. Dimensional drawings showing panelboard enclosure details.
4. Panelboard anchorage details with design calculations signed by licensed Engineer.

C. Testing: All equipment and terminations shall be tested in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology and the NETA acceptance testing specification.

D. Certificates of Compliance: Seismic qualification certification from the manufacturer including mounting recommendations.

E. Reports: Shop test reports shall be submitted.

F. Operations and Maintenance Manuals shall be submitted in accordance with the Specifications.

1.6 QUALITY ASSURANCE

A. General:
1. All panelboards shall conform to the applicable NEMA and UL Standards and shall be built by one approved manufacturer who shall use only best commercial materials and processes of manufacture.
2. All panelboards shall be UL listed.
3. The panelboards manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all shop tests. Calibration of testing apparatus shall be within one year.
4. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology.

B. The panelboards shall be designed, constructed and installed suitable for earthquake regulations in accordance with the seismic requirements of the Nassau County Building Code and the Uniform Building Code for zone 2A application.

1.7 DELIVERY, STORAGE AND HANDLING

A. Panelboards shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Panelboards shall be manufactured by ABB, EATON, SQUARE-D or approved equal.

2.2 PANELBOARDS

A. General:
   1. The panelboards shall be dead-front type with automatic trip-free, bolt-on, molded case circuit breakers.
   2. The panelboards shall be equipped with main breakers or main lugs, branch circuit breakers, 1-pole, 2-pole and 3-pole, as shown on the Contract Drawings.
   3. The panelboards shall be enclosed in flush or surface mounted cabinets as shown on the Contract Drawings.

B. Ratings:
   1. Panelboard ampacities, voltage, number of phases and wires shall be as shown on the Contract Drawings. Panelboard frequency shall be 60 Hz.
   2. Panelboards shall be labeled with a UL short circuit rating. All panelboards shall be fully rated.
   3. Panelboards rated 240VAC or less shall have a short circuit rating of 22,000A RMS symmetrical, unless shown otherwise on the Contract Drawings.
   4. Panelboards rated 480VAC shall have a short circuit rating of 65,000A RMS symmetrical, unless shown otherwise on the Contract Drawings.

C. Bus Bars:
   1. Bus bars shall be copper sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.
   2. Bus bar taps for single-pole branches shall be arranged for sequence phasing of the branch circuit devices.
   3. A bonded ground bus shall be included in all panels.
   4. Full-size neutral bars shall be provided for panelboards, unless noted otherwise on the Contract Drawings.
   5. Where specifically shown on the Contract Drawings or stated in the Specifications, panelboards shall be provided with a 200 percent rated neutral bus suitable for use with non linear loads. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

D. Cabinets:

1. Cabinets shall be constructed of 12 gauge galvanized steel with stainless steel hardware. Fronts shall have doors over circuit breakers and trims of proper width. Doors shall be fastened to the trims with concealed hinges and shall be equipped with flush-type catches and locks. All locks shall be keyed alike.
2. Cabinets shall have wiring gutters on the sides. Cabinets shall be at least 5-3/4 inches deep and 20 inches wide for panelboards with maximum branch circuit breakers of 100A. When branch circuit breakers are above 100A, cabinets shall be at least 9-1/2 inches deep and 31 inches wide.
3. Cabinets shall be NEMA 12 for dry, indoor areas and NEMA 4X for corrosive areas. In hazardous locations, panelboards shall have a NEMA 7 rating.
4. Cabinets shall have identifying nameplates in accordance with the requirements of Specification 16076 - Labeling and Identification.
5. All panelboard directories shall have both the equipment name and the tag identification number. Where this will not physically fit in the standard panelboard directory, an additional expanded directory mounted behind the standard directory shall be supplied containing the above information.

E. Circuit Breakers:
1. Circuit breakers shall be the molded case type conforming to NEMA Standard AB-1.
2. Breakers shall be the bolt-on type with quick-make, quick-break, toggle mechanism for manual as well as automatic operation. Breakers shall have 100 amp frames, with 15 amp trip elements as minimum, unless otherwise shown on the Contract Drawings. All 100 amp frame breakers shall be fixed thermal magnetic trip units. Frame sizes above 100 amp shall have interchangeable thermal magnetic trip units.
3. Where specifically shown on the Contract Drawings or stated in the Specifications, breakers shall be provided with electronic trip units. Electronic trip units shall provide long time, short time, instantaneous and ground fault settings and time adjustments as minimum.
4. Where specifically shown on the Contract Drawings or stated in the Specifications, ground fault circuit interrupters shall be provided. Ground fault breakers shall be equipped with solid state sensing and 5 milliamp sensitivity.
5. Breakers used for lighting circuit switching shall be suitable for the purpose and shall be marked "SWD". Breakers requiring continuous operation shall be provided with a lock-on device.
6. Where specifically shown on the Contract Drawings or stated in the Specifications, shunt trips, bell alarms, and auxiliary devices shall be provided.

F. Directories:

1. Each panel shall be provided with a directory. Panel directories shall be typewritten, and shall have designations of each branch circuit. The directory shall be protected by a glass or noncombustible plastic cover.

2. The Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service and the number of spares. This directory shall be updated as work progresses, and final, typewritten directories shall be provided at the end of the Contract.

3. Where execution of the work under this Contract requires certain circuits to be modified, the Contractor shall update the panelboard directories if available to reflect the modifications. Final typewritten directories shall be provided at the end of the Contract.

2.3 PAINTING

A. All metal surfaces of the panelboard enclosures shall be thoroughly cleaned and given one coat of zinc chromate primer. All interior surfaces shall then be given one shop finishing coat of a nitro-cellulose enamel lacquer.

B. All exterior surfaces shall be given three coats of the same lacquer. The color of finishing coats shall be light gray ANSI No. 61.

2.4 RUBBER MATS

A. Contractor shall furnish and install floor mats. Floor mats shall be of prime quality rubber compound, free of calendering and curing defects and shall be resistant to weather, aging and ozone in normal concentrations. Mats shall be 5/8-inch thick and shall be custom made to sizes shown with beveled edges.

B. Floor mats shall be furnished and installed along the entire front, back and side of each transformer furnished and installed under this Contract.

C. Mat shall be black with yellow safety stripe on edge as manufactured by American Floor Mats, series double-duty anti-fatigue mats.

2.5 SHOP TESTS

A. Shop tests shall be performed at the panelboard's manufacturer's plant prior to shipment. Shop tests shall demonstrate that the equipment tested conforms to the requirements specified.

B. Each panelboard shall be given a 60 Hertz, AC, Hi-Pot test, phase to phase and phase to ground, at twice rated voltage plus 1000 volts for one minute, 1500 volts minimum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Panelboard shall be mounted rigidly and securely to the building structure or to supporting devices which are rigidly and securely supported to the building structure. Anchor panelboards to satisfy seismic requirements in accordance with the anchorage details.

B. Panelboards shall be fastened with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on metal.

C. Mount all panelboards parallel or perpendicular to walls, such that panelboards are installed in a neat and professional manner.

D. All wiring shall be neat within the panelboards. Wires shall be run vertically in the wire gutter and then terminate horizontally at a breaker.

E. The Contractor shall install blanking devices within panelboard spaces so bus bars are not exposed.

F. Install panelboard nameplates for identification of equipment.

G. Panelboard circuits shall be installed so to balance the loads on each of the panelboards.

+ + END OF SECTION + +

SECTION 16442

ELECTRICAL CONTROL EQUIPMENT - LOW VOLTAGE AC MOTORS & DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing electric control equipment. Electric control equipment shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

1.2 RELATED SPECIFICATIONS

A. Specification 16036 – Testing

1.3 PAYMENT

A. Payment for electric control equipment shall be made as provided in the Specifications.

1.4 REFERENCES

A. Electric control equipment shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.
   2. UL Standard No. 98, Enclosed Switches.
   3. UL Standard No. 508, Industrial Control Equipment.
   4. NEMA Standard KS-1, Enclosed Switches.
   5. NEMA Standard ICS, Industrial Control and Systems, General Requirements.
   6. NEMA Standard ICS 2, Industrial Control and Systems, Controllers, Contactors and Overload Relays.
   7. NEMA Standard ICS 5, Industrial Control and Systems, Control Circuit and Pilot Devices.
   8. NEMA Standard ICS 6, Industrial Control and Systems, Enclosures.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:

1. Prior to equipment submission, submit a list of proposed manufacturers with products they produce proposed for the contract.

2. Manufacturer's catalog cuts, technical information and enclosure details for the electric control equipment.

C. Operations and Maintenance Manuals shall be submitted in accordance with the Specifications.

1.6 QUALITY ASSURANCE

A. Unless otherwise shown on the Contract Drawings, stated in the Specifications or directed by the standards and codes referenced under this section, the Contractor shall provide for each low voltage motor or other power device, complete equipment for starting and control.

B. The starting and control equipment shall be provided with features of protection, current limitation and functioning and be complete with all accessories, appurtenances and supporting structures.

C. Control equipment shall be UL listed and properly designed with relation to the characteristics of operation of the motor and device controlled.

D. Unless otherwise shown on the Contract Drawings or stated in the Specifications, each motor shall be provided with control equipment consisting of apparatus as follows:
   1. Motors of 1/4 HP or less may, in the absence of other requirements, shall be controlled by a manual motor starter having thermal overload protection at all times.
   2. Motors larger than 1/4 HP shall be controlled by a magnetic motor starter.
   3. For wound rotor motors of all horsepower ratings, the primary shall be controlled by a magnetic motor starter. Secondary control shall be magnetic or manual as stated in the Specifications.
   4. Multiple speed squirrel cage motors, shall be controlled by a magnetic motor starter. The magnetic motor starter shall provide adequate protection of the motor at each speed. A line establishing contactor shall be provided for each motor speed.

E. Each motor shall include overload protection based on latest standards.

1.7 DELIVERY, STORAGE AND HANDLING

A. Electric control equipment shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's instructions.

1.8 SPARE PARTS

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the electric control equipment in accordance with the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. The following spare parts shall be furnished:
   1. One (1) set of contact tips, shunts and coils shall be provided for each 6 or less of each size motor starter.
   2. One (1) auxiliary contact unit or one set of auxiliary contact tips shall be provided for each 6 or less motor starter.
   3. Two (2) sets of arc chutes shall be provided for each type and rating of magnetic contactor.
   4. One (1) timing relay shall be provided of each type installed as part of control equipment installation.
   5. One (1) complete auxiliary relay shall be provided of each type installed as part of control equipment installation.
   6. One (1) control transformer shall be provided of each rating and type installed as part of control equipment installation.
   7. Two (2) complete fuse replacements shall be provided of each rating and type installed as part of control equipment installation.

PART 2 - PRODUCTS

2.1 SWITCHING DEVICES

A. Switching devices shall be provided in accordance with the details shown on the Contract Drawings. The switching devices required under this section shall be the disconnect switch and circuit breaker types.

B. Switching devices shall be enclosed in NEMA type enclosures in accordance with the requirements specified under Article 2.5.

C. Disconnect switch type switching devices shall be in accordance with the following:
   1. Switches shall be heavy duty type with number of poles, voltage and current ratings as shown on the Contract Drawings.
   2. Switches shall be capable of interrupting the full rated current at full rated voltage. Where specifically shown on the Contract Drawings, disconnect switches shall be complete with fuses.

3. Switches shall be the quick make and quick break type covered with an arc resisting barrier. The switch shall be provided with provision for locking in either open or closed position. The ratings shall be as follows:

	Motor Horsepower	
Switch Rating in Amperes	208-240 v.	480v.
60	Over 5 to 15	Over 5 to 30
100	Over 15 to 25	Over 30 to 60
200	Over 30 to 50	Over 60 to 125
400	Over 50 to 75	Over 125 to 200

D. Circuit breaker type switching devices shall be in accordance with the following:
   1. Circuit breakers shall be the molded case type with number of poles, voltage and current ratings as shown on the Contract Drawings.
   2. Breakers shall be manually operated thermal magnetic type, including inverse-time overload and instantaneous short-circuit protection. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of arc chutes.
   3. Breakers shall have 100 amp frames as a minimum. Overload protection shall be provided on all poles, with trip settings as shown on the Contract Drawings. Breakers with frame sizes 225 amp or larger shall have interchangeable trip units and adjustable magnetic trip elements.
   4. Breakers shall be operated by a toggle-type handle and shall have a quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Breaker enclosure shall be equipped with an external lockable handle with provision for locking in the closed or open position.
   5. Where specifically shown on the Contract Drawings or stated in the Specifications, breakers shall be provided with electronic trip units. Electronic trip units shall include long time, short time, instantaneous and ground fault settings as minimum.
   6. Where specifically shown on the Contract Drawings or stated in the Specifications, breakers shall be provided with shunt trips, bell alarms and auxiliary devices.

E. Switching devices shall be by Cutler-Hammer, General Electric Company or approved equal.

2.2 MAGNETIC MOTOR STARTERS

A. Magnetic motor starters shall be provided complete with fused control power transformer, pilot devices, auxiliary contacts and accessories as shown on the Contract Drawings or stated in the Specifications.

B. Magnetic motor starters shall be enclosed in NEMA type enclosures in accordance with the requirements specified under Article 2.5. The starter shall be combination type. The enclosure shall be equipped with an external operable, pad lockable handle, arranged so that it is impossible to open the door unless the breaker is open.

C. The starter shall be magnetic coil operated, and shall include a magnetic only motor circuit protector with trip unit range adjustable from 700 to 1300 percent of full load. The combination starters shall be suitable for interrupting 65,000 amps through 480 volts.

D. Magnetic contactors shall be 3 pole, single throw, 110-550 volt, ac, 60 cycles with auxiliary contacts for under-voltage protection. Contactors shall be mounted upon steel bases with insulated mountings or upon bases of insulating material. Contactors shall be provided with necessary barriers and arc chutes.

E. Contactors shall be NEMA rated as follows:

	Motor Horsepower	
NEMA Size of Contactor	208-240v.	480v.
1	1/4 to 7-1/2	1/4 to 10
2	over 7-1/2 to 10	over 10 to 25
3	over 15 to 25	over 25 to 50
4	over 30 to 40	over 50 to 100
5	over 50 to 75	over 100 to 200

F. Contactors in Sizes 1 through 4 shall have double break, silver to silver main contacts. Contactors in Size 5 shall have silver plated tips which close with rolling action and which have self-aligning and self cleaning features. Auxiliary and interlocking contacts for all sizes shall be of the silver button type. All contact tips shall be easily renewable. Flexible shunts shall be tinned copper braid or tinned extra flexible copper cable.

G. Thermal overload relays shall be of the ambient compensated bi-metallic type with separate interchangeable heaters and manual reset feature. Relay shall include a normally open auxiliary contact for remote alarm purposes. Heaters for overload relays shall be selected to match full load currents of the motors to allow motor operation at maximum safe loads without damage to equipment. Full load current data shall be obtained from nameplates of motors actually installed.

H. Pilot devices shall be heavy duty type, rated 10 amp continuous. Pushbuttons, selector switches, indicating lights, and other devices shall be located on the starter enclosure. Indicating lights shall be push-to-test, transformer type with 12 volt secondaries.

I. Relays shall be standard, latching type and pneumatic or solid state time delay type. Relays shall be provided with contacts rated 10 amp with number as required.

J. Special overload protection shall be provided where definite purpose motors cannot be protected by standard thermal overload relay applications.

K. Magnetic motor starters shall be by Cutler-Hammer, General Electric Company, Furnas Electric Company or approved equal.

2.3 MANUAL MOTOR STARTERS

A. Manual motor starters shall be provided complete with pilot devices as shown on the Contract Drawings or stated in the Specifications.

B. Manual motor starters shall be enclosed in NEMA type enclosures in accordance with the requirements specified under Article 2.5.

C. Manual motor starters shall be toggle operated, NEMA horsepower rated, single phase type with thermal overload protection unless shown otherwise on the Contract Drawings or stated in the Specifications. Pilot devices when required shall be in accordance with the requirements specified under Article 2.2.

D. Where shown on the Contract Drawings, manual motor starters shall be 600 volt, three phase type without overload protection for use as manual starting disconnect switches. The switches shall be NEMA size 0 or 1 horsepower rated, as required for the application intended.

E. Manual motor starters shall be by Cutler-Hammer, General Electric Company, Furnas Electric Company or approved equal.

2.4 CONTROL STATIONS

A. Control Stations shall be provided in accordance with the details on the Contract Drawings.

B. Control Stations shall be enclosed in NEMA type enclosures in accordance with the requirements specified under Article 2.5.

C. Control stations shall be industrial, heavy duty, oil tight construction with clearly marked legend plates. Stations shall have operating devices as shown on the Contract Drawings.

D. Contact ratings shall be 10 amp minimum. All indicating lights shall be transformer type with 6 volt lamp, lens color shall be as shown on the Contract Drawings.

E. Control stations shall be by General Electric Company, Furnas Electric Company, Cutler-Hammer, or equal to be approved by the Engineer.

F. All control stations associated with electric motor powered equipment shall be provided with both red "running" and green "stopped" indicating lights. Additional indicating lights shall be provided as shown on the Contract Drawings.

2.5 ENCLOSURES

A. Enclosures shall be provided for the electric control equipment. Enclosures located indoors in dry, dusty areas shall be gasketed and shall be constructed of 14 gauge sheet steel. Cabinet type enclosures shall include hinged and gasketed front doors.

B. Enclosures shall be provided in accordance with NEMA requirements as required for the area classifications indicated on the Contract Drawings.

C. For dry, dusty locations, enclosures shall meet NEMA 12 requirements. For wet and corrosive locations, enclosures shall meet NEMA 4X requirements. NEMA 4X enclosures shall be fabricated from 316 stainless steel.

D. Unless specifically noted otherwise on the Contract Drawings or stated in the Specifications, enclosures within hazardous locations shall meet Class 1, Division 1, Group D requirements. Hazardous enclosures shall be fabricated from cast metal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment shall be mounted so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Equipment shall be securely fasten to walls or other surfaces on which they are mounted. Independent supports shall be provided where no wall or other surface exists.

C. Electric control equipment shall be installed in conformance with and the National Electrical Code.

+ + END OF SECTION + +

SECTION 16482

MOTOR CONTROL CENTER

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Work Included:

The Contractor shall furnish, installed, test, and place into satisfactory operation the motor control centers (MCCs) as shown on the Contract Drawings and specified herein.

1.2 RELATED SPECIFICATIONS

A.	Specification 16036	-	Testing
B.	Specification 16071	-	Supporting Devices
C.	Specification 16076	-	Labeling and Identification
D.	Specification 16292	-	Power Distribution System Coordination
E.	Specification 16911	-	Electrical Monitoring System

1.3 REFERENCES

A. Motor control centers shall comply with the latest applicable provisions and recommendations of the following:

1.	NFPA 70	-	National Electrical Code
2.	ANSI C37.90.1	-	Surge Withstand
3.	NEMA ICS 3-1	-	Motor control centers
4.	UL 845	-	Motor control centers
5.	NETA	-	International Electrical Testing Association

1.4 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article 4 - Contractor's Working Drawings, Design and Shop Drawings; and as specified under Specifications.

B. Working Drawings

1. Equipment specifications and product data sheets identifying all materials used and methods of fabrication.
2. Complete assembly, layout, and installation drawings with clearly marked dimensions.
3. Equipment cross section drawings.

4. Weights of all component parts, assembled weight of units and approximate total shipping weight.
5. Interconnection Wiring Diagrams.
6. Circuit breaker and fuse time-current curves.
7. Complete motor data and performance characteristics including nameplate data sheet.
8. List of Spare Parts.
9. List of Special Tools.
10. List of recommended lubricants.
11. Painting procedures.
12. Installation instructions.
13. Single line diagram.
14. Internal wiring diagrams for each unit compartment.
15. Motor control center anchorage details with design calculations signed by licensed engineer.

B. Testing Methods
   1. Contractor shall submit a description of shop and field testing methods, procedures and apparatus with calibration dates. Testing methods and procedures shall be submitted at least 45 days in advance prior to conformation of witness testing dates and actual testing.
   2. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least 45 days in advance to actual testing, five recent references with phone numbers shall be submitted.

C. Certificates of Compliance
   1. Submit seismic qualification certificate from the manufacturer including mounting recommendations.
   2. Submit data and results of witness tests accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed.

D. Reports
   1. Submit shop test and field test reports shall be submitted.
   2. Submit manufacturer’s site visit and acceptance testing reports shall be submitted.

E. Operation and maintenance manuals shall be submitted in accordance with the Specifications.

D. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each MCC unit of each motor control center. These final drawings shall be plastic laminated and securely placed inside each MCC unit door and included in the O&M manuals.

1.5 QUALITY ASSURANCE

A. General
   1. Motor control centers shall be designed, built and tested in accordance with the latest applicable editions of ANSI/IEEE, NEMA, UL, NFPA and the.
   2. All structures shall be fabricated of code gauge steel. Steel surfaces shall be chemically cleaned, treated and finished with ANSI No. 61 indoor light grey paint.
   3. The motor control center manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all factory tests. Calibration of testing apparatus shall be within one year.
   4. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology and the NETA acceptance testing specification.
   5. The motor control centers shall be designed, constructed and installed suitable for earthquake regulations in accordance with the seismic requirements of the Uniform Building Code for zone 2A application.
   6. Products used in the work of this Section shall be produced by manufacturers regularly engaged in the manufacturing, installing and servicing of similar items with a history of successful production acceptable to the Engineer as specified herein and in accordance with Article 5 of the General Conditions.

B. The Contractor shall submit certification that manufacturer has been producing motor control centers for a minimum of five (5) years.

C. Field Tests
   1. The motor control centers shall be field tested. Field testing shall be performed in accordance with the requirements specified under Article 3.02.
   2. The services of the motor control center manufacturer shall be retained for field service. Field service shall be in accordance with the requirements specified under Article 3.03.
   3. Retain the service of an independent testing firm who shall perform field acceptance testing of the motor control centers. The testing firm shall have experience in the inspection and testing of the equipment and shall be a member company of NETA. Provide proof of membership, or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer. Acceptance testing shall be in accordance with the requirements specified under Article 3.04.

1.6 DELIVERY, STORAGE AND HANDLING

A. Motor control center equipment shall be delivered, stored and handled in accordance with the Specifications, the manufacturer's instructions and the following.
   1. Motor control center equipment shall be inspected for shipping damage or loose parts when received. Evidence of water which may have entered equipment during transit shall be checked.

2. Motor control center equipment shall be lifted, rolled or jacked into locations shown on the Contract Drawings.
3. Motor control center equipment shall be stored in a clean, dry location in which a uniform temperature is maintained. Equipment shall be protected with coverings and maintain air circulation.
4. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.

1.7 SPARE PARTS

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the motor control centers in accordance with the Specifications.
B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.
C. Spare parts shall be furnished in accordance with the manufacturer's recommendations. Spare parts for each motor control center shall include at a minimum the following:

1. One (1) of each circuit breaker size for each ten (10) provided, minimum of one (1) if less than ten (10).
2. Three (3) of each fuse size provided.
3. One (1) of each meter or monitor for each five (5) provided, minimum of one (1) if less than five (5).
4. One (1) of each starter size for each ten (10) provided, minimum of one (1) if less than ten (10).
5. All manufacturer recommended spare parts.

1.8 SYSTEM DESCRIPTION

A. In general, the motor control centers included under this Section shall include, but not be limited to, the following:
1. Main disconnecting devices.
2. Motor starters and controls.
3. Feeder disconnecting devices.

4. Control wiring and interlocking.
5. Metering, monitoring and communication equipment.

1.9 DESIGN REQUIREMENTS

A. The Contractor shall review installation procedures under other Sections and Contracts and coordinate them with the work specified herein.

B. The Contractor shall notify other Prime Contractors in advance of the installation of the work included to provide them with sufficient time for installation and coordination of interrelated items that are included in their Contracts and that must be installed in conjunction with the work included in this Section.

C. In all cases where a device or part of the equipment is referred to in this Section in the singular (such as motor starter), it is intended that such references shall apply to as many such devices as are required to complete the installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Motor control center manufacturers and their particular products shall be as follows:
   1. ABB, "ReliaGear"
   2. Eaton, "Freedom"
   3. Square-D, "Model 6"
   4. Or approved equal.

2.2 GENERAL

A. The motor control centers shall be 600 volt class suitable for operation on a three phase, 60 hertz system. The system operating voltage shall be 480V. Number of wires, bus ampacity, and short circuit withstand capability shall be as shown on the Contract Drawings.

B. In addition, refer to Contract Drawings for actual layout and location of equipment and components, electrical ratings of devices, components and assemblies, and other details.

C. Motor control centers shall contain wiring similar to NEMA Class II, Type B. All inputs and outputs shall be wired to I/O terminal blocks.

D. The circuit breakers, motor circuit protectors, disconnect switches and motor starters shall have a short circuit withstand rating equal to the bus short circuit withstand rating.

E. The Contractor shall obtain the new motor control centers from one manufacturer who shall also manufacture the enclosure and major equipment components, which includes, but is not limited to, starters, variable frequency drives, branch circuit breakers, main circuit breaker, power monitoring equipment, and other components of the equipment assembly. Subcontracting of wiring is not acceptable.

F. The motor control center shall be assembled/modified using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured and labeled in compliance with IEC standards is not acceptable.

2.3 STRUCTURE

A. Structures shall be totally enclosed dead-front, free-standing assemblies. They shall be 90 inches high and 20 through 22 inches wide. Larger widths of 24, 30 or more inches shall be utilized for oversized starters, automatic transfer switches, programmable logic controllers, variable frequency drives, main breakers, and other components as required. Minimum depth shall be 20 inches.

B. Each MCC shall consist of vertical sections of heavy gauge steel bolted together forming a rigid unit assembly. Removable lifting angles or tabs shall be mounted on top of MCC sections. Removable bottom channel sills shall be mounted front and rear of each vertical section and shall extend the full width of line-up.

C. MCC enclosures shall be NEMA Type 12 dust-tight and drip-proof.

D. Each vertical section shall contain a top and bottom horizontal wireway for incoming lines and wiring between sections. A vertical wireway shall be adjacent to each vertical unit and shall be covered by a hinged door. Vertical wireways shall contain cable tie supports. Each individual device compartment shall have a side barrier to permit pulling wire from vertical wireway without disturbing adjacent device compartments.

E. Compartments for mounting control units shall be incrementally arranged such that not more than six (6) NEMA Size 1 starters can be mounted within any vertical structure. Guide rails shall be provided.

F. Motor control centers shown “back-to-back” on the Contract Drawings shall be complete motor control assemblies placed back-to-back in the location shown. Motor control center sections with common horizontal and/or vertical bus systems are unacceptable.

2.4 BUS ARRANGEMENT AND MATERIALS

A. Each structure, including the I/O compartment sections, shall contain a main horizontal tin-plated copper bus. Vertical busses supplying unit compartments shall be tin-plated copper, shall be 300A minimum or fully rated for larger equipment, and

shall be securely bolted to the horizontal main bus. All joints shall be front accessible for ease of maintenance.

B. Main bus shall be isolated from wireways, starters and other areas by insulated barriers. Bus bars shall be supported on polyester reinforced insulators.

C. Vertical busses shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical busses to prevent any fault generated gases to pass from one phase to another. Small openings in bus sandwich shall permit unit stabs to plug into vertical bus bars, rather than onto them. An automatic shutter mechanism shall be furnished to completely isolate vertical bus, including stab area opening, when plug-in device is removed.

D. Each MCC shall contain a tin-plated copper ground bus which extends the full width of the MCC. The ground bus shall be rated 300A, unless shown otherwise on the Contract Drawings. Pressure type ground lugs shall be mounted on the ground bus in the incoming line sections.

E. A vertical plug-in ground bus shall be tin-plated copper and linked to the horizontal ground bus. This tin-plated copper vertical plug-in ground bus, in combination with the unit ground bus stab, shall establish unit insert grounding before the plug-in power stabs engage the power bus, and conversely, as the unit is withdrawn, grounding is maintained until after the plug-in power stabs are disengaged.

F. A vertical load ground bus shall be tin-plated copper and linked to the horizontal ground bus. The bus assembly shall provide a termination point for the load equipment grounding conductor(s) at the unit. The fixed connection shall not have to be removed when the unit is withdrawn from the MCC.

G. For 3-phase, 4-wire systems, a tin-plated copper neutral bus shall be furnished when shown on the Contract Drawings. The neutral bus shall extend the full width of the MCC and shall be fully rated unless shown otherwise on the Contract Drawings.

2.5 UNIT COMPARTMENTS

A. General
   1. Each unit compartment shall be provided with an individual front door. Each front door shall have a drawing holder mounted on the inside of the door for holding final, “as-built” wiring diagrams. Each plug-in unit shall be supported and guided by a removable unit support pan, so that the unit rearrangement is easily accomplished. The rearrangement of the unit support pan from one location to the other shall be accomplished without use of tools. After insertion, each plug-in unit shall be held in

place by at least one multi-turn latch, located on the front of the unit. The latch shall be located for front accessibility and inspection convenience.

2. Unit compartments shall contain circuit breakers, combination motor starters, fused disconnects, and related equipment such as overload relays, control power transformers, terminal blocks, and other components as shown and as specified and required.
3. Full voltage, non-reversing starter units NEMA Size 1 through NEMA Size 5 shall be of the draw out type. Draw out provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Draw out units shall have a stab assembly for connection to the vertical bus. Cables shall be connected to stabs with maintenance free crimp connectors. No wiring to these stabs shall extend into the bus compartment.
4. All unit compartment interiors shall be painted white.
5. All units shall be isolated from one another, above and below, by unit support pans or steel barriers which can remain in place when the units are withdrawn.
6. Incoming line compartments shall be isolated from horizontal and vertical wireways by steel barriers.
7. Each incoming line unit shall contain buswork and fittings as required with cable lugs for cables of sizes and quantities shown on the Drawings. Cable lugs shall be suitable for their respective conductors.
8. For 3-phase, 4-wire systems, a neutral landing pad shall be furnished in the incoming line or main circuit breaker sections.

B. Operating Mechanisms: An operating mechanism shall be mounted on the primary disconnect of each feeder or starter unit. It shall be mechanically interlocked with the unit door to prevent access unless the disconnect is in the OFF position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. A second interlock shall be provided to prevent removal or reinsertion of the unit while in the ON position. Padlocking facilities shall be provided to positively lock the disconnect in the OFF position with from one (1) to three (3) padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.

C. Main and Tie Circuit Breakers
   1. Main and tie circuit breakers shall be the molded case type. All main and tie circuit breakers shall contain electronic trip units for device coordination curve adjustments. As a minimum, adjustments shall include:

      a long-time pick-up and delay
      b short-time pick-up
      c ground fault pick-up and delay
      d instantaneous pick-up

2. The Contractor shall be responsible for determining and setting all required breaker parameters for proper system operation.
3. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
4. The main and tie circuit breakers shall contain properly sized rating plugs, as shown on the Contract Drawings. Rating plugs shall be removable.
5. Main and tie circuit breakers shall have operating mechanisms as described above.
6. Where shown on the Contract Drawings, main circuit breakers shall have internal or external auxiliary devices capable of monitoring and transmitting electrical quantities to remote locations. See Articles 2.6 and 2.7 for details.

D. Feeder Circuit Breakers

1. Feeder circuit breakers shall be the molded case type (as described above). Breakers shall be manually operated and shall provide thermal magnetic, inverse-time overload, and instantaneous short-circuit protection. Provide electronic trip units for 400 AF circuit breakers and larger. Provide electronic trip units for smaller frame size circuit breakers if available.
2. Feeder circuit breakers shall have 100A frames as a minimum. Overload protection shall be provided on all poles, with trip settings as indicated on the Contract Drawings. Circuit breakers with 225A or larger frames shall have interchangeable trip units and adjustable magnetic trip elements.
3. Feeder breakers shall have operating mechanisms as described above.
4. Feeder breakers shall have internal or external auxiliary devices capable of monitoring and transmitting electrical quantities to remote locations. See Articles 2.6 and 2.7 for details.

E. Combination Motor Control Units shall consist of a main disconnect device, a motor starter, a control power transformer, an overload relay, control relays, pilot devices, terminal blocks, and modules for communications and motor protection as described below. Additional control relays or other devices shall be included as required and as shown on the Contract Drawings.

1. Disconnect Device

a The disconnect device shall be either a circuit breaker (as described above), motor circuit protector, or fused disconnect as shown on the Contract Drawings.
b Motor circuit protectors (MCP) shall be molded case devices similar to circuit breakers (as described above) with a current sensing coil in each of the 3-poles and shall have an adjustable magnetic trip setting by means of a single dial, mounted on the front of the MCP. The MCP shall be designed to meet the NEC requirements concerning motor full load and locked-rotor current.
c The settings of the MCPs shall be based on actual motor nameplate data.
d The MCPs shall have operating mechanisms as described above.
e Disconnect switches shall be heavy duty, single-throw fused type.
f Switches shall be rated 600V and shall have ampere ratings and number of poles as shown on the Contract Drawings.
g Switches shall be quick-make/quick-break and shall accept Class R dimension fuses.
h Disconnect switches shall have operating mechanisms as described above.

2. Motor Starters and Overload Relays

a Motor starters shall be electrically operated, electrically held, threepole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight (8) normally open (NO) or eight (8) normally closed (NC) auxiliary contacts. The overload protection shall consist of one (1) current sensor located in each phase monitored by the microprocessor that yields a time current curve closely paralleling that of motor heating damage boundary, accurate to 2%. Running overload protection shall be DIP switch selectable for the specific motor full load amperes within the starter range. Provide DIP switch selectable overload trip class of 10, 20 and 30.
b Motor starters shall monitor current in each phase to provide phase loss and phase unbalance protection, such that if the unbalance on any of two phases is greater than 30% of the DIP switch selected trip rating, a phase loss/unbalance trip occurs. Provide phase loss/unbalance protection which requires no time delay for reset.
c Motor starters shall provide ground fault protection. Ground fault protection shall be set at 20% of maximum continuous ampere rating and have a start delay of 20 seconds, and a run delay of 1 second to prevent nuisance trip on starting.
d The microprocessor shall measure control circuit voltage and prevent closing of the coil on low-voltage (78 volts AC) and/or high-voltage (135 volts AC) conditions which are outside of the coil ratings.
e The microprocessor shall apply voltage to the coil such that a guaranteed maximum of two (2) milliseconds of main contact bounce occurs on contactor closure.

f The microprocessor shall continuously measure coil circuit voltage and current so as to maintain constant coil power at a level to maintain main contact closure and minimize coil power consumption.

g Provide Control Modules to perform the indicated input/output control functions shown on the Contract Drawings. Module to incorporate faceplates having membrane type pushbuttons and LEDs. All pushbutton and LED functions to be furnished with clearly written identification. Modules to be provided with the ability to replace conventional start, stop, hand, auto, and control functions, and when utilized in starter applications, overload reset function.

h Provide, where indicated on the Contract Drawings, a Metering Module capable of displaying control voltage, status and where utilized on starter applications, cause of trip, current at time of trip and current in each phase.

i Provide an addressable communication card capable of transmitting all data over a compatible two-wire local area network to a central personal computer for storage and/or printout. The network shall also be capable of transmitting data in RS232c format via a translator module. The following data shall be able to be transmitted:

1) ON-OFF reset control functions.
2) Status (ON, OFF, TRIPPED, NO RESPONSE)
3) Current in each phase
4) Percent phase unbalance
5) Control voltage
6) Overload protection settings
7) Cause of trip
8) Trip current magnitude

3. Control Power Transformers

a Control power transformers (CPT) shall be provided with each combination motor control unit. CPTs shall be 480V-120V, 60 Hz unless shown otherwise, and shall have the following minimum volt-amp ratings:

NEMA Size Starter	VA
1 & 2	200
3	500
4&5	500

b Additional transformer capacity shall be provided when required.

c CPTs shall be epoxy encapsulated, core and coil units designed for machine tool applications. Insulation classes shall be 185°C (NEMA) and 180°C (UL), 115°C rise. Maximum surface temperature shall be 65°C.

d CPTs shall be provided with one secondary lead furnished with a Class H control fuse and clip, and the other secondary lead grounded. Both primary leads shall be provided with Class CC control fuses and clips. The above fusing shall apply to all CPTs unless shown otherwise on the Contract Drawings.

4. Control Relays

a Control relays shall be machine tool type and shall be furnished and installed as required in the unit compartments, or in individual relay panels as shown on the Contract Drawings.

b Control relays shall be rated 600V with contacts rated 10A continuous, and shall be capable of making 7200VA and breaking 720VA. Coil voltage shall be 120V, 60 Hz unless shown otherwise.

c Contacts shall be bifurcated and convertible.

d Relays shall be standard, latching type or time delay type, and shall be furnished with the number of contacts required. Each relay shall contain a minimum of two (2) normally open and two (2) closed contacts.

5. Terminal Blocks

a Terminal blocks shall be mounted on the right side or bottom of the unit compartment for easy accessibility. Control terminal blocks shall be pull-apart type on plug-in units for easy removal of the unit from the structure. Control terminal blocks on non plug-in units shall be the fixed type.

b Control terminal blocks shall be rated 20A, 600V minimum.

c Pull-apart power terminal blocks shall be 3-pole rated 60 A at 600 volts and shall be supplied through NEMA Size 2 starters. Non-pull-apart terminal blocks rated 195 A at 600V shall be supplied for NEMA Size 3 and larger starters.

F. I/O Compartments

1. All new motor control centers shall be provided with two (2) empty sections 90 inches high by 30 inches wide and 20 inches deep for housing of system I/O equipment provided by others. All required status and command terminal points within the MCC shall be wired to terminal strips located in the lower section of these compartments. The I/O supplier(s) shall mount his equipment on a subpanel constructed to meet the requirements of the MCC manufacturer. All I/O points shall be connected to terminals using the PLC manufacturer's pre-assembled wiring

harnesses. Upon completion of the I/O wiring and subsequent testing, the 16482-16 I/O supplier(s) shall ship all completed components to the construction site.

2. Under the direct supervision of the I/O supplier(s), the subpanel assemblies shall be installed in the motor control centers and terminal to terminal wiring. Typical I/O shall be provided for all spare and future MCC compartments with an additional twenty percent (20%) of each type of I/O provided as spare. All I/O including spare and future, shall be wired to the terminal strips provided and identified.
3. The I/O suppliers may include the Contractor, based on the particular requirements of each MCC.

G. Transient Voltage Surge Suppression

1. The new motor control centers shall be furnished with integrated transient voltage surge suppression (TVSS) equipment suitable for large distribution equipment applications. TVSS equipment shall be provide for each incoming source of power to the motor control center.
2. The TVSS equipment shall be factory installed by the motor control center manufacturer.
3. The TVSS equipment shall include a disconnect switch and shall be installed using a direct bus connection. There shall be no cable connections between devices.
4. The TVSS shall be connected for seven modes of operation, line to line, line to neutral (as required), line to ground, neutral to ground (as required). The TVSS shall be rated 100,000 A. TVSS shall be tested in accordance with NEMA LS-1. TVSS shall be designed, rated and installed in accordance with UL 1449. Third party test results shall be included in the submittal.
5. The TVSS equipment shall be Cutler-Hammer Clipper Power System Model CPS-S2, General Electric Company equivalent, or equal.

2.6 MICROPROCESSOR-BASED METERING EQUIPMENT

A. General: Metering shall be furnished and installed where shown on the Contract Drawings. Metering shall include electronic meters, switches, potential transformers, control power transformers, current transformers, terminal blocks, fuses, and other components as required for proper operation, whether shown on 16482-17
the Contract Drawings or not. All meters shall be door mounted. Meters shall communicate and transmit data to a remote computer.

B. Sub Metering Modules (Feeder Breakers)

1. Feeder breakers shall be supplied with a UL listed microprocessor-based Sub Metering Module (SMM). The SMM shall be available to directly attach to 150-ampere, 250-ampere and 400-ampere frame molded case circuit breakers. Where required for use with a circuit greater than 400A, a SMM for use with external current transformers shall be supplied.
2. The SMM, when utilized with its associated circuit breaker and connected via twisted pair network to the monitoring system Central Energy Display (CED) and/or computer, shall be capable of providing the following information in Units, Kilo-units or Mega-units as applicable:

    a. WATTS
    b. Present Watt Demand (5-, 10-, 15-, 30-, or 60-minute window)
    c. Peak Watt Demand (same window s Present Watt Demand)
    d. Watt-hours

3. Accuracy of the SMM shall be ±1% of the breaker frame rating through a range of 0.1 to 1.25 of the breaker frame rating. The SMM shall be suitable for 60-cycle power systems with a Power Factor of from 90degree lagging to 30-degree leading.
4. Communications capability shall be provided to transmit information over a local area network at 9,600 baud. The communications network shall be noise immune to 60-cycle power and utilize a non-polarized shielded twisted pair of #18 wires.
5. Each SMM shall include all of the following features:

    a. When used with a 125A, 250A, or 400A circuit breakers, the SMM shall have the same width and depth dimensions as its associated molded case breaker along with integral voltage stabs for mounting it directly to the circuit breaker. Device shall include built-in neutral and communications terminals and a transmit LED.
    b. For circuits 400A and less, include three (3) built-in integral doughnut current transformers, suitable for having the load side cables passed through them and being directly connected to the circuit breaker terminals without decreasing the code required bending space. For loads greater than 400A, provide three (3) current transformers.
    c. The SMMs shall be powered directly from the monitored circuit and shall not need any separate control power source.
    d. Include integral DIP switches for establishing its own address for the monitoring system.

C. Metering Monitor and Protection (Main Breakers)

1. Where indicated on the Contract Drawings, provide a digital line Meter Monitor and Protection (MM&P) device having the features and functions specified below.

The MM&P shall be UL listed, CUL and CE certified and also meet ANSI Standard C37.90.1 for surge withstand.

2. The MM&P shall provide direct reading metered or calculated values of the items listed below and shall auto range between Units, Kilo-units and Mega-units for all metered values. Accuracy indicated below to be a percentage of the full scale of the device.
   a. AC amperes in each phase, ± 0.3% accuracy
   b. AC voltage, phase-to-phase, phase-to-neutral, ±0.3% accuracy
   c. Watts, ±0.6% accuracy
   d. Vars, ±0.6% accuracy
   e. VA, ±0.6% accuracy
   f. Power factor, 1.0% (±1 digit) accuracy g Frequency, ±0.1% Hz accuracy
   g. Watt Demand (5-, 10-, 15-, 20-, 25-, 30-, 45-, 60-minute interval programmable or from utility synchronizing pulse)
   h. Watt hours, ±0.6% accuracy
   i. Var hours, ±0.6% accuracy
   j. VA hours, ±0.6% accuracy
   k. % THD measures through 31st harmonic
3. The MM&P shall display minimum and maximum values of the following metered parameters:
   a. Voltage, line-to-line, line-to-neutral
   b. Current, per phase
   c. Power, watts, Vars and VA
   d. Power factor, displacement and apparent
   e. Frequency
4. The MM&P shall also display peak percent THD and demand parameters.
5. The MM&P shall monitor and display positive and negative Watts, Vars and power factor. The sign convention shall be selectable between mathematical or power engineer's convention. The MM&P shall display net energy at the device and shall display reverse, forward and net energy via the communications port.
6. The following adjustable protective alarm features shall be provided. Alarm shall be communicated via the communications port or by Form C relay output contacts as shown on the Contract Drawings. Each relay shall be programmable to operate as latched or unlatched (self-resetting), and programmable to operate in mode 1 (energized) or mode 2 (de-energized) when the trigger occurs.

   a. Voltage phase loss, if any phase RMS is less than 50% of the nominal line voltage.
   b. Current phase loss, if the smallest phase value is less than 1/16 of the largest phase value.
   c. Line voltage phase unbalance, selectable from 5 to 40% of nominal in 5% increments.

d. Voltage phase reversal.
e. Overvoltage, selectable from 105 to 140% in 5% increments.
f. Undervoltage, selectable from 95 to 60% in 5% increments.
g. Time delay (adjustable from 0 to 20 seconds in 1 second intervals) for overvoltage, undervoltage and phase unbalance trip and alarm settings.

7. Input ranges of the MM&P shall accommodate external current transformers with ratios from 5:5 Amperes through 5:12,800 Amperes. Provide external current transformers with rating as indicated on the Contract Drawings or sized for incoming service. The 600-volt and below voltage power module shall be detachable from the chassis. Three (3) inline fuses shall protect the MM&P from current overloads. Fused potential transformer shall be self-included up to 600 volts.
8. The display face shall be membrane type and rated suitable for NEMA 3R and NEMA 12 mounting. The MM&P shall have a durable six-digit LED display screen. The display screen and LEDs shall indicate two (2) alarm conditions. The cause of a trip alarm shall be indicated in the display window.
9. The MM&P shall have an operating temperature range of -20 degrees C to 70 degrees C, and 0 to 95% relative humidity non-condensing.
10. A neutral terminal shall be provided and wired for 4-wire, grounded systems.
11. In the event of an alarm condition, a built-in reset button shall allow a manual reset of the MM&P. The MM&P shall also be capable of being remotely reset via its communication port. The MM&P shall have the capability for resetting watt-hours, VAR-hours, VA-hours, Minimum/Maximum values, and demand.
12. The MM&P control power shall be capable of being supplied from the monitored incoming line without the need for a separate AC supply control circuit or separate remote power source (96- to 264-volt AC or 100- to 350-volt DC).
13. The MM&P shall have non-volatile memory and not require battery backup in the event of a power failure. The MM&P shall retain all pre-set parameters, accumulated watt-hours, and watt demand.
14. Provide an addressable communication card capable of transmitting all data, including trip data, over a compatible two-wire local area network to a central personal computer for storage and/or printout. The network shall also be capable of transmitting data in RS232c format via a translator module.

D. Current and Potential Transformers

1. Current transformer accuracies shall be such as to provide satisfactory performance for the burdens to be applied; in the case of metering equipment over a range of 10 to 100 percent of rated current.
2. When potential transformers are required they shall have a metering accuracy for all burdens to 150 VA.

3. Potential transformers and fuse assemblies shall be mounted singularly or in groups.
4. All meters shall be for operation from these transformers, having nominal 5 ampere or 120V secondaries, for current transformers and potential transformers respectively.

2.7 MICROPROCESSOR-BASED METERING EQUIPMENT - DISPLAY UNITS

A. Central Monitoring Unit

1. Where shown on the Contract Drawings, provide a Central Monitoring Unit (CMU) or approved equal. The CMU shall be a microprocessor based, self-contained device (NEMA 3R/12 faceplate) suitable for door mounting and shall perform the functions listed below. Each assembly shall have provisions for a communications module to provide for remote computer monitoring up to 10,000 feet.
2. The CMU shall be suitable for monitoring and displaying the parameters of up to 99 starters or contactors and solid-state overload relays. Communications over the local area network shall be 9,600 baud. Parameters locally displayed at the CMU for each starter and overload relay shall also be capable of being communicated via twisted pair to a remote personal computer. Information displayed at the CMU shall include the following:
   a. Status -- ON, OFF, TRIPPED, NO RESPONSE
   b. Standard address
   c. Three-phase current
   d. Control voltage
   e. Overload condition (alarm)
   f. Cause of device trip
   g. Operations count
   h. Run time
   i. Set points
   j. Starter description and identification
3. The CMU shall pass data to a computer from starters, contactors and overload relays. The master or the host network's baud rate (speed of upper network passing data to a computer) shall be independent of the CMU's subnetwork baud rate. The master or host network's baud rate shall be established via the communications module while the CMU's subnetwork baud rate shall be switch selectable on the rear of the CMU.
4. The program directing the functions or the CMU shall be permanently stored in the CMU. There shall be no need to reload data after AC power loss.
5. The addresses, types of devices and descriptions shall be stored in memory during the learn mode and shall also be retained throughout a power loss. Unless there has been a change, it shall not be necessary to re-enter the learn mode after a power loss.
6. The CMU shall have an 8-digit alphanumeric display to monitor active data, trip data or set points which are available from the individual motor control devices. The CMU shall have three (3) LEDs to indicate which group of data is being displayed, as selected through membrane-type alphanumeric pushbuttons by the user. The

CMU shall have a 2-digit alphanumeric display to indicate the address of the control device for which data is being displayed. The CMU shall have membrane type push buttons to allow the user to step up or down to select the control device to be displayed. The CMU shall have two (2) additional LEDs at the top of the CMU to indicate that the CMU is operational and when there is an "alarm" status on one of the motor control devices. The CMU shall have an "acknowledge/reset" membrane-type pushbutton to permit the user to reset the CMU following a motor control device trip.

7. The CMU shall be suitable for operation from a 120-volt, single-phase input.
8. The CMU shall have a "Help" button function, which shall scroll English explanations in the alphanumeric window for any condition or abbreviations.
9. Provide an addressable communication card capable of transmitting all data, including trip data over a compatible two-wire, local area network to a central personal computer for storage and/or printout. Provide data and time-stamping for all starter/contactor operations. Reprogramming of the
10. CMU shall not be required when adding a communication module. The network shall also be capable of transmitting data in RS232c format via a translator module.

B. Central Energy Display

1. Where shown on the Contract Drawings, supply a Central Energy Display (CED), device for monitoring and displaying the information from the Sub Metering Modules (SMM) and Meter Monitor & Protection (MM&P) devices. The CED shall be a microprocessor-based, self-contained device suitable for door mounting and shall perform the below-listed functions. Each CED shall have provisions for a communications module to provide for remote computer monitoring up to 10,000 feet away.
2. The CED shall be capable of monitoring and displaying parameters of up to 50 SMMs and up to eight (8) Meter Monitor & Protection (MM&P) devices. There shall be separate step-up and step-down buttons to select specific SMMs or MM&P devices by means of a device address in a display window. In addition to the device address, a user programmed, custom descriptive name for each remote device shall be displayed. The following parameters shall be displayed on a front NEMA 12 membrane faceplate for each remote device as it is selected:

    a. Energy Consumption (kilowatt-hours)
    b. Peak Power Demand (kilowatts)
    c. Present Power Demand (kilowatts)
    d. Group readings -- The CED shall have the ability to sum the energy, peak power demand and present power demand readings for up to eight (8) user-selected device groups.
    e. Status of each remote device -- active, inactive or no response
    f. Historical alarm log.
    g. Date and time.

3. The CED shall be capable of being programmed to alarm for any of the following conditions:
   a. Whenever the value and time duration of a peak demand exceeds the user programmed maximum for both individual SMMs and groups of SMMs.
   b. On inactive SMM or loss of response from a SMM.
4. The user shall have the option at setup of deciding whether or not a security code is needed to access the acknowledgment for alarms and resetting of alarms. The alarms shall also be capable of being acknowledged and reset by remote computer over the twisted pair network.
5. The CED shall have the following features:
   a. The CED shall be self-learning and poll its subnetwork and store the addresses of the SMMs and MM&Ps on the network. This shall be done automatically after the unit is turned on for the first time or shall be capable of being entered and displayed in an 8digit alphanumeric window.
   b. The microprocessor shall have non-volatile memory and shall retain the addresses, types and description of devices during an AC power loss that have been previously stored in memory during the learn mode.
   c. The CED shall have a real-time clock which is battery-backed.
   d. The CED shall be suitable for 50- or 60-cycle, 240-volt or 120-volt control power (10 VA maximum power consumption).
   e. The CED shall be suitable for operating conditions from 0 degrees C to 70 degrees C with a humidity of 0 to 95% Relative Humidity non-condensing.
   f. Alarm contacts shall be rated 10 amperes at 250-volt AC resistive, or 30 volts DC 1/3 hp at 125 or 250 volts AC.
6. The CED shall have the following communications capability:
   a. Communications to the various subnetwork devices shall be over a single twisted pair of conductors, with communications speed field selectable at either 1,200 or 9,600 baud for distances up to 10,000 feet.
   b. Provide for the addition of a CED communications module which will allow the CED to communicate with a remote master at either 1,200 or 9,600 baud. Communications modules shall be available for either communicating to a remote computer or programmable
   c. controller over a compatible, two-wire, local area network system, or over RS232c protocol.

2.8 WIRING

A. Control and power wiring shall be flame-retardant (VW-1) moisture, heat and oil resistant thermoplastic insulation rated 600V, 90°C, with stranded copper conductors, types MTW and THW.

B. Control wires shall be red. Power wires shall be black. Neutral wires shall be white. Ground wires shall be green.

C. Control wire size shall be #14 AWG minimum. Power wire size shall be #10 AWG minimum.

2.9 KEY INTERLOCK SYSTEMS

A. Key interlock systems shall be provided as indicated on the Contract Drawings and as specified herein.

1. At each double-ended MCC, the key interlock system shall be designed to prevent paralleling of the two incoming sources.
2. The Contractor shall furnish and install the interlock components at each MCC to ensure the completeness and satisfactory operation of each system.
3. Key interlock system manufacturer shall be Kirk, or approved equal.

2.10 PAINTING

A. Paint shall be in accordance with the requirements of Specification 09900 – Painting.

B. Motor control centers shall be painted light-gray ANSI 61 over a phosphate rust inhibitor. All unit compartment interiors shall be painted white over a phosphate rust inhibitor.

2.11 SHOP TESTS

A. Certified Shop Tests
1. Test equipment to demonstrate that it has been properly assembled, properly lubricated, is not overheating, is not overloading, and has no electrical or mechanical defects.
2. Perform all certified shop test and submit the shop test reports prior to scheduling the witness shop test.

B. Witnessed Shop Tests:

1. The Contractor shall perform witnessed shop tests in accordance with General Conditions Article GC-19.

2. Shop testing shall be performed on the motor control center at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of

ANSI and shall demonstrate that the equipment tested conforms to the requirements specified. All shop testing will be witness by three (3) County representatives.

3. The Contractor shall include the cost for three (3) County representatives (airfare, food, hotel – one occupant per room, and transportation) to attend and witness all factory shop tests.

4. Obtain engineer's approval of the testing procedure and test stand layout prior to scheduling a witness shop test.

5. Witness shop test shall include all the manufacturer's standard factory testing protocol including but not limited to test all disconnecting devices, starters and controls, stimulate controls for each starter and verify all contracts, relays, and other devices operate properly. Verify all meters, monitors and communication devices operate properly. Verify all miscellaneous devices such as power supplies, transfer devices, and other equipment operate properly.

6. The Contractor shall provide a certified shop test report. The report shall identify the tests performed and the results obtained.

7. The Contractor shall submit and obtain acceptance by the Engineer of the witness shop test report prior to shipment of the equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Equipment shall be installed in accordance with manufacturer's instructions and recommendations. The Contractor shall follow manufacturer's instructions as to lifting requirements, connecting shipping splits and attachment to structure.
2. Equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance. The Contractor shall verify NEC clearances as shown on the Contract Drawings, prior to installation.
3. Equipment shall be installed on concrete pads at locations shown on the Contract Drawings. Steel channels shall be provided for support of equipment. Equipment shall be securely mounted to surface with anchor bolts. Anchor the equipment to satisfy the specified seismic requirements in accordance with the anchorage details.
4. The Contractor shall coordinate conduit entry locations through the pad with the General Contractor. Conduit locations shall be based on manufacturer's shop drawings.

B. Wiring: The Contractor shall wire all equipment per the Contract Drawings and as required.

C. Adjustments: The Contractor shall test and adjust all equipment within the MCC. This includes short circuit and overload device settings, electronic trip settings of breakers, MCP settings, timing relay settings, and other required settings. All devices shall be properly adjusted such that the MCC protection and control circuits operate correctly and safely.

3.2 FIELD TESTS

A. After installation, motor control centers shall be field tested for operation and conformance. The Contractor shall perform field testing in accordance with the Specifications. The field tests shall be witnessed by the Engineer and certified by the Contractor.

B. Motor control center testing shall be performed by the manufacturer's representative, prior to energizing equipment. The testing shall be in accordance with the recommendations of the manufacturer's representative. Equipment shall not be energized without the permission of the Engineer.

C. After installation of the equipment, controls and all appurtenances, field test the equipment for system operation and conformance to the specified performance parameters. The Contractor shall perform field tests in accordance with Article 12 of the General Conditions - General Requirements. Test the equipment to demonstrate the following:

1 Equipment has not been damaged in transportation and installation.
2 Equipment has been properly installed.
3 Equipment has been properly lubricated.
4 Equipment has been properly connected.
5 Equipment is not overheating.
6 Equipment is not overloading any part.
7 The equipment has no electrical or mechanical defects.
8 Compliance with performance and design parameters.
9 System operability under all control schemes.

3.3 GROUNDING

A. The motor control centers shall be properly grounded per NEC requirements. The MCC ground bus shall be connected to ground grid where shown on the Contract Drawings.

B. Conduits entering the MCC shall have insulated grounding bushings tied together with copper jumper cables.

3.4 IDENTIFICATION

A. Each motor control center shall be identified with the identification number indicated on the Drawings (e.g. MCC 02-04-13). A nameplate shall be securely affixed in a conspicuous place on each MCC. Nameplates shall be as specified in Specification 16076 Labeling and Identification.

3.5 RUBBER MATS

A. Surface mats shall be of prime quality rubber compound, free of calendaring and curing defects and shall be resistant to weather, aging and ozone in normal concentrations. Mats shall be 5/8-inch thick and shall be custom made to sizes shown with beveled edges.

B. Floor mats shall be furnished and installed along the entire front of each switchgear furnished and installed under this Contract, i.e., a continuous run along the front of the Medium Voltage Metal-Clad Switchgear.

C. Mat shall be black with yellow safety stripe on edge as manufactured by American Floor Mats, series double-duty anti-fatigue mats.

3.6 MANUFACTURER'S FIELD SERVICES

A. A qualified manufacturer's representative shall make the necessary modifications to the existing motor control centers as specified herein and indicated on the Contract Drawings. The representative shall also assist in the installation of the new motor control centers, check the motor control center installation before it is placed into operation, assist in the performance of field tests, observe and assist initial operations and train the plant operations and maintenance staff in the care, operation and maintenance of the equipment.

B. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction and all other pertinent information.

C. The service representative shall sign in with the Engineer on each day they are at the site.

3.7 ACCEPTANCE TESTING

A. The Contractor shall provide acceptance testing of the motor control centers. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under Article 3.2. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

B. Acceptance testing inspection shall be performed on each motor control center. Inspection shall include the following:

1. Physical, electrical and mechanical condition shall be inspected.
2. Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.
3. All connections shall be inspected for high resistance.
4. Electrical and mechanical interlock systems shall be checked for proper operation.
5. Insulators shall be inspected for evidence of damage or contamination.
6. Equipment shall be cleaned and lubricated as required.

C. Acceptance electrical testing shall be performed on each motor control center. Testing shall include the following:

1. Ground-resistance tests shall be performed.
2. Contact-resistance test shall be performed.
3. Control and metering wiring performance test shall be performed.
4. Circuit breaker trip characteristics shall be determined by primary current injection.

D. All tests and values shall be in accordance with the manufacturer's recommendations and NETA, ATS Acceptance Testing Specification.

E. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA, ATS Acceptance Testing Specification.

+ + END OF SECTION + +

SECTION 16491

FUSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing fuses. Fuses shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The fuses required under this section shall be the medium voltage class and the low voltage class. The fuses of each class shall be suitable for use with power circuits.

1.2 PAYMENT

A. Payment for fuses shall be made as provided for in the Specifications.

1.3 REFERENCES

A. Fuses shall comply with the latest applicable provisions and recommendations of the following:
   1. UL 248, Low Voltage Fuses.
   2. NEMA SG2, High Voltage Fuses.
   3. ANSI C37.40, Standard Service Conditions and Definitions for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
   4. ANSI C37.41, Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
   5. ANSI C37.46, American National Standard Specification for Power Fuses and Fuse Disconnecting Switches.

1.04 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:

1. Manufacturer's catalog cuts for the fuses proposed for use with specifications and other data required to demonstrate compliance with the specified requirements.

2. Time - current curves for the fuses proposed for use.

1.5 QUALITY ASSURANCE

A. Low voltage fuses shall be designed, built and tested in accordance with UL 248. Low voltage fuses shall be UL listed by class.

B. Medium voltage fuses shall be designed, built and tested in accordance with NEMA SG2 and ANSI standards C37.40, 41 and 46.

1.6 DELIVERY, STORAGE AND HANDLING

A. Fuses shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's recommendations.

1.7 SPARE PARTS

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare fuses in accordance with the Specifications.

B. The spare fuses shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare fuses shall include at a minimum the following:
1. Medium voltage fuses, three of each rating used.
2. Low voltage fuses, 10 percent of each rating used. Minimum of three per rating.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Low voltage fuses shall be by Bussmann, Ferraz Shawmut or approved equal.

B. Medium voltage fuses shall be by Cutler-Hammer, General Electric, S&C Electric or approved equal.

2.2 FUSES

A. General:
   1. Fuses shall be provided with a voltage class suitable for the indented service. Fuses shall be compatible with the system operating voltage shown on the Contract Drawings.
   2. Low voltage fuse ampere ratings and medium voltage fuse NEMA E and R ratings shall be as shown on the Contract Drawings.

B. Low Voltage Fuses:
   1. Low voltage fuses shall be current limiting, time delay type. Low voltage fuses shall have a 200,000 RMS symmetrical ampere interrupting rating.
   2. Low voltage fuses with current ratings up to 600 ampere shall be UL class RK1.
   3. Low voltage fuses with current ratings greater than 600 ampere shall be UL class L.

C. Medium Voltage Fuses:
   1. Medium voltage fuses shall be current limiting type, unless stated in the Specifications to be boric acid expulsion type.
   2. Current limiting type medium voltage fuses shall have a 50,000 RMS symmetrical ampere interrupting rating. When boric acid expulsion type medium voltage fuses are used, interrupting ratings shall be as shown on the Contract Drawings.
   3. Medium voltage fuses when used with interrupter switches shall be E rated. When used with motor starters for motor protection, medium voltage fuses shall be R rated.
   4. Medium voltage fuses shall be provided with a blow fuse indicator to signal operation of the fuse element.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fuses shall be installed within equipment in accordance with the manufacturer's recommendations.

+ + END OF SECTION + +

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SECTION 16496

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The Contractor shall provide, test and place into satisfactory operation automatic transfer switches as shown on the Contract Drawings and specified herein.

1.2 RELATED SPECIFICATIONS

A.	Specification 16036	-	Testing
B.	Specification 16071	-	Supporting Devices
B.	Specification 16076	-	Labeling and Identification

1.3 PAYMENT

A. Payment for automatic transfer switches shall be made as provided for in the Specifications.

1.4 REFERENCES

A. Automatic transfer switches shall comply with the latest applicable provisions and recommendations of the following:

1.	NFPA 70	-	National Electrical Code
2.	ANSI	-	American National Standards Institute
3.	IEEE	-	Institute of Electrical and Electronics Engineers
4.	NEMA	-	National Electrical Manufacturers Association
5.	NFPA	-	National Fire Protection Agency
6.	UL	-	Underwriters Laboratories
7.	NETA	-	International Electrical Testing Association

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article 4 – Contractor's Working Drawings, Design and Shop Drawings; and as specified under Division 1 of the Specifications.

B. Working Drawings
   1. Product data sheets identifying all materials used and methods of fabrication.
   2. Complete assembly, layout and installation drawings with clearly marked dimensions.

3. Weights of all component parts, assembled weight of units and approximate total shipping weight.
4. Interconnection Wiring Diagrams
5. List of Spare Parts
6. List of Special Tools
7. Painting procedures
8. Installation instructions
9. Automatic transfer switch anchorage details with design calculations signed by licensed Engineer.

C. Testing Methods
1. The Contractor shall submit description of shop and field testing methods, procedures and apparatus with calibration dates. Testing methods and procedures shall be submitted at least 45 days in advance prior to conformation of witness testing dates and actual testing.
2. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least 45 days in advance to actual testing, five recent references with phone numbers shall be submitted.

D. Certificates of Compliance
1. Seismic qualification certificate from the manufacturer including mounting recommendations.
2. Data and results of witness tests accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed.

E. Reports
1. Shop test and field test reports shall be submitted.
2. Manufacturer's site visit and acceptance testing reports shall be submitted.

F. Operation and maintenance manuals shall be submitted in accordance with the Specifications.

1.6 QUALITY ASSURANCE

A. General
1. Automatic transfer switches shall be designed, built and tested in accordance with the latest applicable editions of ANSI/IEEE, NEMA, UL, and NFPA.
2. All structures shall be fabricated of code gauge steel. Steel surfaces shall be chemically cleaned, treated and finished with ANSI No. 61 indoor light grey paint.

3. The automatic transfer switch manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all factory tests. Calibration of testing apparatus shall be within one year.
4. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology and the NETA acceptance testing specification.
5. Automatic transfer switches shall be designed, constructed and installed suitable for earthquake regulations in accordance with the seismic requirements of the Nassau County Building Code and the Uniform Building Code for zone 2A application.
6. Products used in the work of this Section shall be produced by manufacturers regularly engaged in the manufacturing, installing and servicing of similar items with a history of successful production acceptable to the Engineer as specified herein and in accordance with Article 5 of the General Conditions.

B. The Contractor shall submit the following information pertaining to the manufacturer(s):
1. Certification that manufacturer has been producing automatic transfer switches for a minimum of five (5) years.

C. Field Tests
1. The automatic transfer switches shall be field tested. Field testing shall be performed in accordance with the requirements specified under article 3.2.
2. The services of the automatic transfer switch manufacturer shall be retained for field service. Field service shall be in accordance with the requirements specified under Article 3.03.
3. Retain the service of an independent testing firm who shall perform field acceptance testing of the automatic transfer switches. The testing firm shall have experience in the inspection and testing of the equipment and shall be a member company of NETA. Provide proof of membership, or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer. Acceptance testing shall be in accordance with the requirements specified under Article 3.4.

1.7 DELIVERY, STORAGE AND HANDLING

A. Automatic transfer switch equipment shall be delivered, stored and handled in accordance with the Specifications, the manufacturer's instructions and the following.

1. Automatic transfer switch equipment shall be inspected for shipping damage or loose parts when received. Evidence of water which may have entered equipment during transit shall be checked.
2. Automatic transfer switch equipment shall be lifted, rolled or jacked into locations shown on the Contract Drawings.
3. Automatic transfer switch equipment shall be stored in a clean, dry location in which a uniform temperature is maintained. Equipment shall be protected with coverings and maintain air circulation.
4. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.

1.8 SPARE PARTS

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the automatic transfer switches in accordance with the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts shall be furnished in accordance with the manufacturer's recommendations.

1.9 SYSTEM DESCRIPTION

A. In general, the automatic transfer switches included under this Section shall include, but not be limited to, the following:
   1. Power Section
   2. Control Panel
   3. Enclosure

1.10 DESIGN REQUIREMENTS

A. The Contractor shall review installation procedures under other Sections and Contracts and coordinate them with the work specified herein.

B. The Contractor shall notify other Prime Contractors in advance of the installation of the work included to provide them with sufficient time for installation and coordination of interrelated items that are included in their contracts and that must be installed in conjunction with the work included in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers shall be as follows:

1. ABB
2. ASCO
3. Russelectric Inc.
4. Zenith Controls Inc.
5. Or approved equal.

2.2 GENERAL

A. Each transfer switch shall be rated for the voltage and ampacity as shown on the Contract Drawings and shall have 600 volt insulation on all parts in accordance with NEMA standards.

B. The specified current rating shall be a continuous rating when the switch is installed in an unventilated enclosure, and shall conform to NEMA temperature rise standards.

C. The unit shall be rated based on all classes of loads, that is, resistive, tungsten, ballast and inductive loads. Switches rated 400 amperes or less shall be UL listed for 100% tungsten lamp load.

D. All transfer switches complete with accessories shall be listed by Underwriters Laboratories, under Standard UL-1008 (automatic transfer switches) and approved for use on transfer systems.

E. Transfer switches shall comply with the applicable standards of UL, ANSI, NFPA, IEEE, and NEMA.

F. The transfer switches shall be supplied with a solid state based control panel.

2.3 POWER SECTION

A. The automatic transfer switch shall be of double throw construction operated by a reliable electrical mechanism momentarily energized. There shall be a direct mechanical coupling to facilitate transfer in three (3) cycles or less. Switches composed of molded case breakers, lighting contactors or components thereof will not be acceptable.

B. The Source #1 and Source #2 contacts shall be mechanically interlocked such that failure of any coil or disarrangement of any part shall not permit a neutral position.

C. The automatic transfer switch manufacturer shall certify sufficient arc interrupting capabilities for 50 cycles of operation between Source #1 and Source #2 that are 120 degrees out of phase at 480 volts, 600% of rated current at .50 power factor. This certification is to ensure that there will be no current flow between the two isolated sources during switching.

D. The contact structure shall consist of a main current carrying contact which is a silver alloy with a minimum of 50% silver content. The current carrying contacts shall be protected by silver tungsten arcing contacts on all sizes.

E. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.

F. A manual handle shall be provided for maintenance purposes with the switch deenergized. An operator disconnect switch shall be provided to defeat automatic operation during maintenance, inspection or manual operation.

G. For switches installed in systems having ground fault protective devices, and/or wired so as to be designated as a separately derived system by the NEC, a 4th pole shall be provided. This additional pole shall isolate the Source #1 and Source #2 neutrals. The neutral pole shall have the same withstand and operational ratings as the other poles and shall be arranged to break last and make first to minimize neutral switching transients. Add-on or accessory poles that are not of identical construction and withstand capability are not acceptable.

H. The transfer switch shall have a 3-cycle and closing withstand rating of 100 kA. Current limiting fuses shall be used where required.

2.4 CONTROL PANEL

A. Solid State Control System
   1. The control system for the automatic transfer switch shall be solid state based and shall also contain all logic devices including control and voltage sensing relays, time delays and any auxiliary equipment required for proper operation.

B. Location

   1. All control devices shall be assembled on a door mounted, shielded panel.

2. All components shall be connected with a numbered wiring harness equipped with a disconnect plug that allows isolation of the control panel.

C. Non-Selective Automatic Transfer Switches; Sequence of Operation

1. The ATS shall incorporate adjustable three phase undervoltage monitoring on the two power sources (Source #1 and Source #2).
2. When the voltage of any phase of Source #1 is reduced to 80% of nominal voltage for a period of 1 second (fixed), the transfer switch shall transfer to Source #2 after an adjustable time delay (0-30 seconds).
3. The transfer switch shall remain in the Source #2 position indefinitely. Should any phase of Source #2 be reduced to less than 80% of nominal voltage for a period of 1 second (fixed), the transfer switch shall transfer to Source #1 after an adjustable time delay (0-30 seconds).
4. The transfer switch shall contain red indicating lights. The lights shall indicate switch position. The indicating lights shall be push-to-test, 30 or 30.5MM heavy-duty transformer type. Indicating light voltage shall be 12V.
5. All relays shall be continuous duty industrial type with wiping contacts. Customer interface contacts shall be rated 10 amperes minimum. Coils, relays, timers and accessories shall be readily front accessible.
6. The transfer switch shall contain door mounted transfer/re-transfer pushbuttons. It shall allow operation to switch from Source #1 to Source #2 and from Source #2 to Source #1. Transfer between sources shall be immediate.

2.5 ENCLOSURE

A. The entire transfer switch shall be completely assembled within one (1) enclosure. The enclosure shall be NEMA 12, in dry, indoor areas and NEMA 4X stainless steel in corrosive areas.

B. Exterior surfaces of NEMA 12 enclosures shall be painted gray, ANSI 61. Interior surfaces shall be painted white.

2.6 SHOP TESTS

A. Certified Shop Tests
1. Shop testing shall be performed on the automatic transfer switches at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of NEMA and UL and shall demonstrate that the equipment tested conforms to the requirements specified.
2. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.
3. Automatic transfer switch shop tests shall include the following:

a. Physical inspection shall be performed including torque tests of bus bolts.
b. Mechanical operations shall be performed to insure proper functioning of operating mechanisms and interchangeability.
c. Continuity test shall be performed on power and control wires.
d. Functional operations test which shall include pick up, dropout, time delay, sequence and polarity.
e. Power cables and buses shall be tested, for insulation breakdown resistance and circuit isolation. Test voltage frequency shall not be less than the frequency of the rated voltage of the equipment tested.

4. The transfer switch manufacturer shall submit test data for each size switch, showing it can withstand fault currents of the magnitude and the duration necessary to maintain the system integrity. Each ATS shall be in strict accordance and listed to UL 1008 withstand standards, including 3 cycle ratings.
5. A dielectric test at the conclusion of the withstand and closing tests shall be performed.
6. Temperature rise tests in accordance with UL 1008 shall have been conducted after the overload and endurance tests to confirm the ability of the units to carry their rated currents within the allowable temperature limits.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. The automatic transfer switches shall be furnished and installed as shown on the Drawings and in accordance with the manufacturer's installation instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment. The equipment shall be suitably protected until accepted by the Owner.
2. The equipment shall be installed and checked in accordance with the manufacturer's recommendations. This shall include but not limited to:
   a. Checking to ensure that the pad location is level to within .125 inches if applicable.
   b. Checking to ensure that all power connections are torque to the manufacturer's recommendations.
3. Secure assemblies to foundation on floor channels if applicable.
4. Measure and record Megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four-wire systems only).
5. Automatic transfer switches shall be fully assembled with all required devices, wiring, nameplates, terminal blocks and enclosures.

6. Mount automatic transfer switches rigidly and securely to the building structure or to supporting devices, which are rigidly and securely supported to the building structure.
7. Automatic transfer switches shall be fastened with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work.
8. Mount automatic transfer switches with sides parallel or perpendicular to walls or equipment.
9. Install all automatic transfer switches such that door swing is not hampered.

B. Locations and Sizes
1. Automatic transfer switches locations shown on the Contract Drawings are approximate. Sizes shall be as dimensioned on the Contract Drawings, or, if not specifically dimensioned, as required to house all devices, terminal blocks and conduits which enter the enclosure.
2. All automatic transfer switches sizes and locations shall be submitted by the Contractor for the Engineer's approval.

C. Grounding
1. All automatic transfer switches shall be grounded in accordance with NEC requirements.
2. The use of two (2) locknuts and a grounding bushing shall be required at all conduit terminations where hub type fittings are not required. Conduit grounding bushings within automatic transfer switches shall be bonded together with jumper cables where enclosure size or number of conduits warrants their use per NEC requirements.

D. Terminal Blocks
1. Terminal blocks shall be installed parallel or perpendicular to the automatic transfer switch enclosure sides. Approximately 20 percent spare terminals shall be provided (minimum of two (2). Terminals shall be lettered or numbered to conform to the wiring diagrams.

E. Wiring
1. The wiring within the automatic transfer switch shall be neatly harnessed to prevent the door damaging the wiring and to prevent the wiring from hampering the door operation.
2. All conductors shall have identification markers on each end. Marker numbers shall match the terminal block numbers consistent with the Shop Drawings.

3.2 FIELD TESTS

A. After installation, automatic transfer switches shall be field tested for operation and conformance. The Contractor shall perform field testing in accordance with the Specifications. The field tests shall be witnessed by the Engineer and certified by the Contractor.

B. Automatic transfer switch testing shall be performed by the manufacturer's representative, prior to energizing equipment. The testing shall be in accordance with the recommendations of the manufacturer's representative. Equipment shall not be energized without the permission of the Engineer.

3.3 MANUFACTURER'S FIELD SERVICES

A. A qualified manufacturer's representative shall assist in the installation of the automatic transfer switches, check the automatic transfer switch installation before it is placed into operation, assist in the performance of field tests, observe and assist initial operations and train the plant operations and maintenance staff in the care, operation and maintenance of the automatic transfer switches.

B. The Contractor shall provide equipment start-up services and training in accordance with the Specifications.

C. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction and all other pertinent information.

D. The service representative shall sign in with the Engineer on each day they are at the site.

3.4 ACCEPTANCE TESTING

A. The Contractor shall provide acceptance testing of the automatic transfer switches. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under Article 3.2. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

B. Acceptance testing inspection shall be performed on each switchgear. Inspection shall include the following:
   1. Physical, electrical and mechanical condition shall be inspected.

2. Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.
3. All connections shall be inspected for high resistance.
4. Electrical and mechanical interlock systems shall be checked for proper operation.
5. Insulators shall be inspected for evidence of damage or contamination.
6. Equipment shall be cleaned and lubricated as required.

C. Acceptance electrical testing shall be performed on each automatic transfer switch. Testing shall include the following:
1. Ground-resistance tests shall be performed.
2. Insulation-resistance tests shall be performed on each bus, phase-to-phase and phase-to-ground.
3. Test each pole with other poles grounded. An over potential test shall be performed.
4. Contact-resistance test shall be performed.
5. Control and metering wiring performance test shall be performed.

D. All tests and values shall be in accordance with the manufacturer's recommendations and NETA, ATS Acceptance Testing Specification.

E. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA, ATS Acceptance Testing Specification.

3.5 PAINTING

A. After fabrication, bonderize, chemically clean and paint exterior and interior surfaces of the switchboard with a rust inhibiting primer followed by an ANSI 61 gray finish coat cathodic electro-deposition epoxy.

B. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

3.6 IDENTIFICATION

A. Each automatic transfer switch shall be identified with the identification number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each automatic transfer switch. Nameplates shall be as specified in Specification 16076 Labeling and Identification.

3.7 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each automatic transfer switch. The mat shall be long enough to cover the full length of the equipment line-up. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

+ + END OF SECTION + +

SECTION 16511

LIGHTING FIXTURES AND DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing lighting fixtures and devices. Lighting fixtures and devices shall be provided in accordance with the requirements specified under this section, the Specifications and the Contract Drawings.

B. The lighting system shall be complete and include all luminaires, devices and accessories as required for the installation of the lighting fixtures and devices.

1.2 RELATED SPECIFICATIONS

A. Specification 16076 - Labeling and Identification

B. Specification 16131 - Electric Conduit System

1.3 PAYMENT

A. Payment for lighting fixtures and devices shall be made as provided for in the Specifications.

1.4 REFERENCES

A. Lighting fixtures and devices shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electric Code.
   2. UL Standard No. 20, General Use Snap Switches.
   3. UL Standard No. 844, Electric Lighting Fixtures for Use in Hazardous Locations.
   4. UL Standard No. 894, Switches for Use in Hazardous Locations.
   5. UL Standard No. 924, Emergency Lighting and Power Equipment.
   6. UL Standard No. 935, Fluorescent Lamp Ballasts.
   7. UL Standard No. 1010, Electrical Receptacle - Plug Combinations for Use in Hazardous Locations.
   8. American National Standard Institute, ANSI.
   9. Certified Ballast Manufacturers, CBM.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the

requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:

1. Prior to equipment submission, submit a list of proposed manufacturers with the products they produce proposed for the contract.
2. Manufacturer's catalog cuts and drawings showing all technical information, and construction details for lighting fixtures, including dimensions, type of wiring, weight, size, installation methods and provisions for relamping lighting fixtures from the ground.
3. Photometric data, fixture IES lighting classification, and isolux diagram developed for each fixture type.
4. Lamp type and technical information.
5. Ballast type and technical information including power factor, input watts and ballast factor.
6. Scaled working drawings showing the locations of all fixtures and devices. The Drawings shall include the proposed routing of the branch circuits.
7. Point-to-point photometric layout drawings detailing the footcandle levels at one foot intervals, six inches above the finished floor. For exterior areas, the footcandle levels shall be detailed at one foot intervals, six inches above grade. For stairways, the footcandle levels shall be detailed at one foot intervals, six inches above each step.
8. Bills of material.

C. Reports:
1. Field test reports shall be submitted.
2. Manufacturer's site visit report shall be submitted.

D. Operations and Maintenance Manuals shall be submitted in accordance with the Specifications.

1.6 QUALITY ASSURANCE

A. General:
1. Lighting fixtures shall be UL listed. The lighting fixture types are noted within the fixture schedule. The descriptions and catalog numbers serve to establish the quality, appearance and performance of the specified lighting fixtures.
2. All lighting fixtures shall be the products of lighting equipment manufacturers who have previously demonstrated, by performance and reputation, the ability to manufacture products of the quality specified. Such manufacturers must maintain an organization and manufacturing facility capable of actually manufacturing the specified lighting fixtures. For the purpose of inspection, Contractor shall assure the Engineer, free and easy

access to the manufacturing facilities and inventories of any manufacturer whose equipment the Contractor proposes to supply.

3. The Contractor shall be responsible to assure that the exact inscription for exit and stairway signs required by local code is checked against that specified, prior to providing same. The Engineer shall be advised of any changes required to conform to local codes before such changes are effected.
4. The Contractor shall be responsible for reviewing all drawings of each Contract and coordinating with all trades the installation of lighting fixtures and devices. The lighting fixture and device finishes and construction shall be compatible with the wall and ceiling types based upon the Contractor's review of all drawings of each Contract.
5. All industrial fixtures shall be of the highest quality material and construction for their respective types.
6. Lamps for all lighting fixtures shall be in accordance with the Federal Energy Legislation for reduced energy consumption.
7. Fixtures shall be suitable for connection to concealed or exposed conduit runs as required in each particular location and shall be of sizes suitable for lamp sizes indicated on the Contract Drawings.
8. Fittings and other materials for special fixtures not definitely shown or specified shall be of approved material, make and quality and shall have a finish that will harmonize with other parts of the fixtures. Where suitable standard materials are not available such parts of the fixtures shall be specially manufactured.

B. Field Testing:
   1. The lighting fixtures shall be field tested. The field testing shall be performed in accordance with the requirements specified under Article 3.03.
   2. Retain the services of the emergency inverter system manufacturer for field services. Field service shall be in accordance with the requirements specified under Article 3.04.

1.7 DELIVERY, STORAGE AND HANDLING

A. Lighting fixtures and devices shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's instructions.

1.8 SPARE PARTS

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the lighting fixtures in accordance with the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. The following spare parts shall be furnished:
   1. 10 percent lamps shall be provided of each type of LED fixture, but not less than the requirement for five fixtures.
   2. 10 percent fuses shall be provided of each size and type, but not less than two.

PART 2 - PRODUCTS

2.1 LIGHT FIXTURES

A. A lighting fixture shall be provided for each fixture symbol shown on the Contract Drawings. Light fixtures shall be provided in accordance with the lighting fixture schedule shown in the Specifications.

B. Light fixtures shall be provided with all necessary hangers, supports, conduit adaptors, reducers, hooks, brackets and other support hardware. All hardware shall have a protective, non-corrosive finish.

C. Recessed fixtures shall be provided with trim moldings and frames suitable for the types of ceilings.

D. Pendent fixtures shall be suspended by means of an enclosed and gasketed cushion type hanger. The hanger shall be suitable to be mounted directly to the fixture outlet box and shall provide a minimum of 8 degrees swing from the vertical. Fixture stems shall be threaded rigid metal conduit, 1/2 inch minimum size. In corrosive areas stems shall be PVC coated.

E. Where fixtures are subjected to moisture, or assembled of dissimilar metals, gaskets of approved material and thickness shall be provided.

F. Explosion-proof type fixtures shall comply with the requirements of the National Electric Code for the hazardous locations indicated on the Contract Drawings.

G. Fixtures shall be completely wired except where they will be directly connected to branch circuit wiring. The conductors shall be not less than No. 12 gauge, stranded, with approved heat resistant covering.

H. Mounting heights of all fixtures shall be as shown on the Contract Drawings. For special types, the height shall be determined at the time of installation.

I. Metal halide fixtures shall be screw-in type. The only wiring required shall be attaching of two (2) wires to a connection block in the mounting hood. Wiring to the ballast shall not be required.

J. Metal halide fixtures shall be constructed of copper free aluminum (4/10 of 1% maximum copper content) for the mounting hoods, ballast bodies and guards. Mounting hoods, ballast bodies and guards shall have an epoxy-clad finish. Finish shall be two (2) coat baked, electrostatically applied for complete uniform surface protection. Reflectors shall be polyester. Globes and refractors shall be heat-resistant prismatic glass.

K. Refer to the Light Fixture Schedule on contract drawing E-SH-1 for all light fixture selections and ratings.

2.2 LAMPS

A. LED Lamps shall have voltage ratings suitable for the voltages shown on the Contract Drawings.

B. Lamps shall be by Acuity or approved equal.

2.3 EMERGENCY INVERTER SYSTEMS

A. Emergency inverter systems shall be provided for operation of exit signs and emergency lighting fixtures. Each system shall be provided with normal input and inverter output voltages, capacity and number of output circuits as shown on the Contract Drawings. The output circuits shall be any combination of up to ten security and emergency circuits.

B. Each system shall consist of a input line circuit breaker, sine wave inverter and battery section complete with the manufacturer's standard monitoring and control functions housed in a vented free standing enclosure. The enclosure shall have identifying nameplates in accordance with the requirements of Specification 16076 - Labeling and Identification. Each system shall be UL 924 listed.

C. The inverter shall be electronic solid state type suitable for operating all type loads. The batteries shall be sealed, maintenance-free lead calcium and shall include a recharge charger and transfer relay.

D. Each system shall operate on AC single phase normal input power supplying both the security circuits and the battery charger. If the normal power is lost, the inverter shall provide, AC single phase emergency power to operate for up to 90 minutes both the security and the emergency circuits.

E. The system output shall automatically switch to battery power within 750 milliseconds upon an outage of the normal input and when restored transfer back after time delay.

F. The emergency inverter systems shall be by IOTA, Emergi-Lite or approved equal.

2.5 LIGHTING CONTACTOR PANELS

A. Lighting contactor panels shall be provided for the control of lighting fixtures where specifically indicated on the Contract Drawings. The panel control and devices shall be arranged for proper operation in accordance with the control schematics shown on the Contract Drawings.

B. The panel enclosures shall be steel, single door type. Enclosures shall be NEMA 12 for dry, indoor areas and NEMA 4X for corrosive areas. Each enclosure shall be equipped with a control fuse with mounting block and 300 volt screw type terminal blocks.

C. Contactors shall be mechanically held type suitable for 120 volt operation and switching ballast type lighting. Contactor voltage, ampere, number of poles and quantities within each panel shall be as shown on the Contract Drawings.

D. Where indicated on the Contract Drawings, the lighting contactor panels shall be provided with selector switches and control relays. Selector switches and control relays shall be heavy duty industrial type.

2.6 PHOTOCELLS

A. Photocells shall be provided for the control of lighting contactors where specifically indicated on the Contract Drawings. The photocell control and devices shall be arranged facing the northwest sky for proper operation in accordance with the control schematics shown on the Contract Drawings.

B. Photocell Turn-ON shall be 1 to 3 footcandles. Turn-OFF to Turn-ON ratio is 5 footcandles max. Photocell shall contain a time delay for ON and OFF to avoid activation from intermittent artificial light sources.

C. Photocell shall be cadmium sulphide type with solid brass locking prongs, which responds to the light spectrum near to that of a human eye. Photocell shall resists effects of moisture and airborne contaminants.

D. Internal photocell relay shall be Bi-metal providing positive snap action switching, reducing bounce and prolonging contact life.

E. Photocell shall be equipped with a surge arrestor rated 380 joule MOV (metal oxide varistor).

F. Operating temperature range: -40˚ to +140˚F (-40˚ to +60˚C).

G. In the event of unit failure, the photocell switch and remain into the “on” position.

H. Photocell shall be manufactured by Tork, 5000M Series or approved equal.

2.7 RECEPTACLES AND SWITCHES

A. General:
   1. Receptacles and switches shall be provided in accordance as shown on the Contract Drawings. The receptacles and switches shall be complete and shall include all accessories for proper installation.
   2. Outlet boxes for receptacles and switches shall be in accordance with Specification 16131 - Electric Conduit System.

   3. Unless specifically shown otherwise or stated in the Specifications explosion proof devices in hazardous locations shall comply with the requirements of the National Electric Code for Class I, Division 1, Group D locations.

B. Receptacles:
   1. Receptacles shall be duplex grounding type, two pole, three wire, 125 volt AC, 15 ampere. Where shown on the Contract Drawings, other special receptacles with number of poles, voltage and current rating shall be provided. Matching plugs shall be provided for each special receptacle.
   2. Receptacles for indoor dry, dusty locations shall be heavy duty, straight blade type, with reinforced polyester base and impact resistant nylon face.
   3. Receptacles for wet and corrosive locations shall be marine duty, straight blade type, with heat resistance melamine body. Special receptacles in wet and corrosive locations shall be Type 316 stainless steel.
   4. Receptacles for hazardous locations shall be factory sealed. Receptacles for hazardous locations shall be in accordance with the following:
      a. Explosion-proof type receptacles shall be of the delayed action type requiring the turning of a plug shell on withdrawal to allow time for extinction of arcs.
      b. Surface mounted explosion-proof receptacles shall be provided with cast iron or cast aluminum angle type covers with hinged flaps.
      c. Flush mounted explosion-proof receptacles shall be provided with brass, chromium plated, flush plates with double hinged flaps.
      d. Plugs shall be provided where required for each type of explosion-proof receptacle. Plugs shall be of explosion-proof construction, and shall have steel bodies with corrosion resistant finish. Plugs shall be fitted with aluminum alloy cable clamps and chloroprene cable bushings.
   5. Receptacles for installation in floors shall be in accordance with the following:
      a. Floor receptacles shall comprise a watertight unit consisting of a cast iron box with an adjustable top, permitting permanent angular and vertical adjustment, brass cover plate and 3/4 inch brass floor extension. The extension shall be of an approved height and shall be surmounted

with a brass head arranged for a duplex receptacle. Exposed metal parts shall be finished to match adjacent metal finish.

b. For low voltage signal and telephone work, floor outlets shall be equal to those specified above for floor installation, except that the interiors shall be designed for cable extension as approved.

6. Fan or clock outlets shall be single receptacles with molded composition or bakelite bodies. Rating shall be 15 amperes, 125 volts. Fan outlets shall be furnished with stud supports. Clock outlets shall be of the recessed type and shall be furnished with yokes for clock support.
7. 480 volt receptacles in non-hazardous areas shall be a mechanically interlocked type with circuit breaker disconnect. The circuit breaker disconnect cannot be closed until the plug is fully inserted and the plug cannot be withdrawn or inserted unless the switch is open. The receptacle enclosure shall be copper - free aluminum with stainless steel parts. Rating shall be 600 volt, three phase, 60 amperes.
8. Receptacles shall be by Hubbell Incorporated, Arrow-Hart Incorporated or approved equal. Hazardous located receptacles and 480 volt receptacles shall be by Crouse-Hinds Company, Appleton Electric Company, or approved equal.

C. Switches:
1. Switches shall be industrial-heavy duty, AC toggle, quiet type. Switches shall be rated 120/277 volt, 20 ampere. Poles and switching shall be as shown on the Contract Drawings.
2. Switches for hazardous locations shall be factory sealed tumbler type. The switch body and cover shall be cast gray iron alloy or cast malleable iron with zinc electroplate finish.
3. Switches shall be by Hubbell Incorporated, Arrow-Hart Incorporated or approved equal. Hazardous located receptacles shall be by Crouse-Hinds Company, Appleton Electric Company, or approved equal.

D. Plates and Covers:
1. Stainless steel plates shall be furnished for devices in indoor dry, dusty locations. They shall have beveled edges and shall be made of Type 302/304, stainless steel.
2. Plates shall have satin finish. Attachment screws shall have matching head finish.
3. For wet and corrosive locations neoprene gasketed covers shall be used. Covers shall be galvanized ferrous or cast ferrous metal. Covers shall be PVC-coated in corrosive locations. Covers shall be equipped with gasketed spring doors for receptacles and an external operating mechanism for switches.
4. Plates shall be by Hubbell Incorporated, Arrow-Hart Incorporated or approved equal. Covers shall be by Crouse-Hinds Company, Appleton Electric Company, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF LUMINAIRES

A. Luminaires shall be installed at locations shown on the Contract Drawings. Luminaires locations shall be adjusted where necessary to clear conflicts and obstructions.

B. All luminaires shall be installed complete with all hardware, and supporting devices necessary to make a safe complete and fully operative installation. The Contractor shall obtain from the manufacturer for each lighting fixture, diagrams, illustrations and other installation instructions. The Contractor shall install in strict conformance with such instructions and the requirements of NFPA 70 National Electrical Code.

C. LED fixtures shall be installed in conformance with manufacturer's recommendations and to suit the architectural details of the area involved. Independent supports from structural members of the building shall be provided. Unless otherwise shown on the Contract Drawings or stated in the Specifications, every fluorescent fixture shall have at least two supports, and continuous lines of LED fixtures shall be supported at 4 foot intervals,.

D. Pendant mounted fixtures shall be installed with pendants 1/2 inch for stems up to 5 feet and 3/4 inch for longer lengths.

E. All pendant stem hangers shall be furnished with suitable aligner canopies or outlet box covers so that the lighting fixtures hang vertical to the finished floor irrespective of the angle of the surface from which they are suspended. When lighting fixtures or hanger canopies are mounted flush to the ceiling or wall, and where raceways and outlet boxes serving the lighting fixtures are surface mounted to the ceiling or wall, finishing rings shall be provided to conceal the outlet box. All visible hanging devices and appurtenances shall have the same finish as the lighting fixture.

F. Reflectors, lenses, diffusers, louvers and decorative elements of lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting, and general clean-up in the area.

3.2 INSTALLATION OF DEVICES

A. Emergency Inverter System:
   1. Equipment shall be installed in accordance with manufacturer's instructions and recommendations.

2. Equipment shall be installed on concrete pads at locations indicated on the Contract Drawings so that sufficient access and working space is provided for ready and safe operation and maintenance.
3. Install system nameplates for identification of equipment.

B. Lighting Contactor Panels:
1. Panels shall be mounted rigidly and securely to the building structure or to supporting devices which are rigidly and securely supported to the building structure.
2. Panels shall be fastened with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units and with machine screws or welded studs on metal.
3. All panels shall be mounted parallel or perpendicular to walls, such that panels are installed in a neat and professional manner.

C. Receptacles and Switches:
1. Receptacles and switches shall be installed within outlet boxes at locations indicated on the Contract Drawings and in accordance with code requirements.
2. Receptacles shall be mounted 2 feet above the finished floor, except in hazardous locations where receptacles shall be mounted 4 feet-6 inches above the finished floor.
3. Switches shall be mounted 4 feet 6 inches above the finished floor.
4. Where devices are grouped they shall be mounted under a common plate. Where directed or where space conditions limit gang mounting, tandem or tandem gang arrangement shall be provided.
5. Where four or more switches controlling fixtures that are not visible from the switch location are grouped, the switch plate shall be engraved and filled with colored material or otherwise suitably marked to designate the control of each switch.

3.3 FIELD TESTS

A. After installation, the completed lighting system and receptacle devices shall be field tested for operation and conformance. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide testing consisting of the following:
1. Wiring continuity test shall be performed.
2. Branch circuit load balance test shall be performed.
3. Fixture and control operation test shall be performed.
4. Emergency inverter system operation and functionality test shall be performed.
5. Receptacle polarity and grounding.

B. The Contractor shall provide a field test report. The report shall identify the test performed and the results obtained.

3.4 MANUFACTURER'S FIELD SERVICES

A. A qualified manufacturer's service representative shall assist in the installation of the emergency inverter system, check the installation before it is placed into operation, assist in the performance of field tests, observe the initial operation and train the plant operations and maintenance staff in the care, operation and maintenance of the system.

B. The Contractor shall provide equipment start-up services and training in accordance with the Specifications.

C. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training instruction and all other pertinent information.

D. The service representative shall sign in with the Engineer on each day they are at the site.

3.5 CLEANING OF LUMINAIRES

A. Luminaires shall be cleaned inside and out to remove construction dust prior to substantial completion.

B. Fixtures shall be relamped prior to substantial completion.

+ + END OF SECTION + +

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SECTION 16521

OUTDOOR LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for providing outdoor lighting. Outdoor lighting shall be provided in accordance with the requirements under this section, the Specifications and the Contract Drawings.

B. The outdoor lighting system shall be complete and include all luminaires, poles, pole bases, reinforced concrete foundations and accessories as required for the installation of the outdoor lighting.

C. The Contractor shall perform all excavations, complete all forms, and do backfilling and tamping as required, unless specifically shown otherwise on the Contract Drawings or stated in the Specifications.

1.2 RELATED SPECIFICATIONS

A. Specification 02200 - Earthwork
B. Specification 02500 – Surface Restoration
C. Specification 03300 - Cast-in-Place Concrete
D. Specification 05120 - Structural Steel
E. Specification 16511 - Lighting Fixtures and Device

1.3 PAYMENT

A. Payment for outdoor lighting shall be made as provided for in the Specifications.

1.4 REFERENCES

A. Outdoor lighting shall comply with the latest applicable provisions and recommendations of the following:
   1. NFPA 70, National Electrical Code.

1.5 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Prior to equipment submission, submit a list of proposed manufacturers with the products they produce proposed for the contract.
   2. Manufacturer's catalog cuts and drawings showing all technical information, and construction details for lighting fixtures, including dimensions, type of wiring, weight, size, installation methods and provisions for relamping lighting fixtures from the ground.
   3. Photometric data, fixture IES lighting classification and isolux diagram developed for each fixture type..
   4. Lamp type and technical information.
   5. Ballast type and technical information including power factor, input watts and ballast factor.
   6. Pole and base construction details. For poles submit wind loading, complete dimensions and finish, include anchor bolt sizing and circle diameter.
   7. Scaled working drawings showing the locations of all fixtures and shall include the proposed routing of supply conduits.
   8. Point-to-point photometric layout drawings detailing the footcandle levels at one foot intervals, six inches above the finished floor. For exterior areas, the footcandle levels shall be detailed at one foot intervals, six inches above grade. For stairways, the footcandle levels shall be detailed at one foot intervals, six inches above each step.
   9. Bills of material.

C. Reports:
   1. Field test reports shall be submitted.
   2. Manufacturer's site visit report shall be submitted.

D. Operations and Maintenance Manuals shall be submitted in accordance with the Specifications.

1.6 QUALITY ASSURANCE

A. General:
   1. Lighting fixtures shall be UL listed. The lighting fixture type are noted within the fixture schedule. The descriptions and catalog numbers serve to establish the quality, appearance and performance of the specified lighting fixtures.
   2. All lighting fixtures shall be the products of lighting equipment manufacturers who have previously demonstrated, by performance and reputation, the ability to manufacture products of the quality specified. Such manufacturers must maintain an organization and manufacturing facility capable of actually manufacturing the specified lighting fixtures. For the purpose of inspection, Contractor shall assure the Engineer, free

and easy access to the manufacturing facilities and inventories of any manufacturer whose equipment the Contractor proposes to supply.

3. Outdoor lighting system shall use low carbon alloy steel with minimum yield strength of 50,000 p.s.i. or stainless steel bolts, nuts, washers and screws.
4. All industrial fixtures shall be of the highest quality material and construction for their respective types.
5. Lamps for all lighting fixtures shall be in accordance with the Federal Energy Legislation for reduced energy consumption.
6. Fixtures shall be suitable for connection to concealed or exposed conduit runs as required in each particular location and shall be of sizes suitable for lamp sizes indicated on the Contract Drawings.
7. Fittings and other materials for special fixtures not definitely shown or specified shall be of approved material, make and quality and shall have a finish that will harmonize with other parts of the fixtures. Where suitable standard materials are not available such parts of the fixtures shall be specially manufactured.

B. Field Testing: The outdoor lighting system shall be field tested. The field testing shall be performed in accordance with the requirements specified under Article 3.2.

1.7 DELIVERY, STORAGE AND HANDLING

A. Outdoor lighting equipment shall be delivered, stored and handled in accordance with the Specifications and the manufacturer's instructions.

1.8 SPARE PARTS

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the outdoor lighting in accordance with the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. The following spare parts shall be furnished, with all fractions rounded up to the next number:

1. 10 percent lamps shall be provided of each type of LED fixture, but not less than the requirement for five fixtures.
2. 10 percent fuses shall be provided of each size and type, but not less than two.

PART 2 - PRODUCTS

2.1 LUMINAIRES

A. A luminaire shall be provided for each lighting fixture symbol shown on the Contract Drawings. Luminaires shall be provided in accordance with the lighting fixture schedule shown in the Specifications.

B. Luminaires and lighting fixtures shall be provided for each lighting fixture symbol shown on the Contract Drawings. Luminaires, lighting fixtures, and the mounting heights shall be provided in accordance with lighting fixture schedule, specifications and drawings included in Appendix A at the end of this section.

C. Heights of all outdoor fixtures shall be as shown on the Contract Drawings.

D. Refer to the Light Fixture Schedule on contract drawing E-SH-1 for all light fixture selections and ratings.

E. Manufacturer for custom Luminaires shall submit one mock-up and two prototypes to the Engineer for review and approval. The first prototype shall not be fabricated until the mock-up has been submitted and approved. The second prototype shall not be fabricated until the first prototype has been submitted and approved. The production fixtures shall not be fabricated until the second prototype has been submitted and approved. The production fixtures shall be identical to the second prototype except as modified by the Engineer's comments on the second prototype. All prototypes submitted for approval shall be working fixtures constructed of materials identical to those proposed for production including all supports, brackets and fasteners. The contractor shall conduct a shop witness test for each first prototype. The second prototypes shall be installed in their final location and tested at nighttime. Power shall be supplied by the Contractor.

F. Manufacturer for custom luminaires and lighting fixtures shall obtain and submit to the Engineer a certification of approval from UL approval for every custom fixture prior to production.

G. Contractor shall furnish and install LED lighting controller, data power integration box, wire, cable, conduit, and termination resistors for a complete outdoor lighting system.

2.2 POLES AND BASES

A. Poles and bases shall be provided in accordance with the details shown on the Contract Drawings.

B. Poles shall have a wind load rating of at least 110 m.p.h. with a gust factor of 1.3 and shall be made of seamless shaft aluminum or galvanized steel.

C. Where shown on the Contract Drawings, bases shall be provided with plug receptacles, fuses, cut-outs, switches or other devices for protection and ease of maintenance. Devices shall be in accordance with the following:
   1. Receptacles shall be housed in cast iron hot-dipped galvanized boxes and shall be watertight, heavy duty type with screwed caps.
   2. Switches shall be enclosed in hot-dipped galvanized cast iron boxes. Where shown on the Contract Drawings switches shall be provided with fuses.
   3. Where shown on the Contract Drawings, fused applications shall be provided with watertight, in-line fuse kits similar to buchanan breakaway street light connectors.

2.3 REINFORCED CONCRETE

A. Concrete for pole foundations shall be in accordance with Specification 03300 - Cast-in-Place Concrete, and the concrete steel reinforcement shall be in accordance with Specification 05120 - Structural Steel.

PART 3 - EXECUTION

3.1 INSTALLATION OF OUTDOOR LIGHTING

A. Fixtures shall be installed at locations indicated on the Contract Drawings. Fixture locations shall be adjusted where necessary to clear conflicts and obstructions.

B. Excavation for fixture poles shall be in accordance with the requirements of Specification 02200 - Earthwork. Backfilling for fixture poles shall be in accordance with the requirements of Specification 02500 – Surface Restoration.

C. Fixture poles shall be installed on reinforced concrete foundations as shown on the Contract Drawings. Poles shall be installed in accordance with standard procedures and as recommended by the manufacturer.

D. Poles shall be wired with strain relief provided. A green grounding conductor shall be installed with each circuit, grounding by conduit method shall not be permitted.

E. Contractor's field services, including all labor and materials, shall be provided after installation of all fixtures for adjustment, refocusing, field testing of controllers, and re-aiming of all fixtures. Adjustments shall include adjustments to mounting height, length or rotation of the fixtures and their bases. The

Contractor shall provide at least 30 eight hour days of field services on at least six separate visits. The field services will be required during the daytime or during the nighttime, as directed by the Engineer.

3.2 FIELD TESTS

A. After installation, the completed outdoor lighting system shall be field tested for operation and conformance. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide testing consisting of the following:
   1. Wiring continuity test shall be performed.
   2. Branch circuit load balance test shall be performed.
   3. Fixture and photo cell operation test shall be performed.
   4. Point-to-point footcandle measurements shall be performed.

B. The Contractor shall provide a field test report. The report shall identify the tests performed and the results obtained.

3.3 CLEANING OF OUTDOOR LIGHTING

A. Luminaires shall be cleaned inside and out to remove construction dust prior to substantial completion.

B. Fixtures shall be relamped prior to substantial completion.

+ + END OF SECTION + +

SECTION 16701

DISTRIBUTED ANTENNA SYSTEM – DELEGATED DESIGN

PART 1.0 - GENERAL

1.1 DESCRIPTION

A. Deploy an in-building radio signal amplification distributed antenna system (DAS) to ensure comprehensive building coverage, as mandated by the local Authority Having Jurisdiction (AHJ), for public safety agencies. Users of the system must be able to send and receive radio signals using their portable radio units while inside the building. This objective shall be achieved by implementing the following components:

1. Bi-Directional Amplifier(s) (BDA), also referred to as Signal Boosters
2. Battery Back-up Unit(s) (BBU)
3. Coaxial cable
4. Indoor distributed antennas
5. Outdoor donor antenna(s)
6. Connectors
7. Combiners
8. Directional couplers
9. Tappers
10. Power dividers
11. Jumpers

B. These devices shall be used as part of a system, to be designed by a DAS integrator, experienced with design-build projects for in-building public safety amplification systems. Quantities and locations of antennas shall be as determined by the equipment selected and the DAS integrator's design.

C. The system shall comply with the requirements of UL2524 2nd Edition Standard for In-building 2-Way Emergency Radio Communication Enhancement Systems, NFPA 72 2013 Edition, NFPA 1221 2016 Edition and IFC 2018 or later, as referenced.

D. The prompt installation of the indoor two-way emergency responder communication enhancement system is imperative to facilitate the timely issuance of a Certificate of Occupancy.

E. All essential permits required for the commencement of the project installation must be acquired before initiating any work. This includes covering all associated permit expenses and inspection fees.

F. This section encompasses the obligation to fulfill all permit prerequisites in coordination with the Authority Having Jurisdiction (AHJ). In instances necessitating an engineer's endorsement, the documentation shall be presented for the engineer's examination and endorsement. This duty also encompasses the provision of the requisite quantities of floor plans, descriptive notes, specifications, wiring diagrams, shop drawings, and amendment forms.

G. The complete system must comply with the mandates of the Fire Department, the Building Department, and any other relevant agencies and authorities having jurisdiction (AHJ).

H. The in-building emergency responder communications enhancement system shall employ a Guardian Series BDA or an approved equal, bearing UL2524 2nd edition certification from a Nationally Recognized Testing Laboratory (NRTL). It must also adhere to compliance with NFPA 72, NFPA 1221, and IFC 2018 or later editions.

1.2 SCOPE:

A. Delegated Design Project

1. Services: The delegated design DAS integrator shall meet the required qualifications, experience and expertise in the design and installation of Public Safety Radio DAS's.

    a. The installing company shall employ technicians that have a General Radio Operator's License (GROL) and a Manufacturers Certification to supervise the commissioning and testing of the system and to ensure the system's integrity.

    b. Design shall include iBwave software-simulated radio propagation modeling with heat maps showing predicted signal coverage levels within the building. The iBwave design shall be done by iBwave level 2 or higher certified personnel.

2. The DAS shall be able to expand and have the adaptability to accommodate the inclusion or alteration of radio frequencies, as well as future building expansions and renovations.

3. The Bi-Directional Amplifier (BDA) must incorporate alarms compliant with NFPA 72, intended to be linked to an indicating light within the fire alarm panel. The DAS integrator is responsible for coordinating the installation of this alarm light in collaboration with the fire alarm contractor.

4. The DAS Integrator bears the responsibility of choosing suitable locations for the Bi-Directional Amplifier (BDA), coverage, and donor antenna to meet the prescribed coverage criteria. The BDA is to be installed in a designated area such as a Communications room, IDF closet, or an analogous low-voltage electronic control room situated on the highest temperature-controlled level. Enclosure specifications mandate the use of a NEMA4 enclosure for the BDA.

5. An approved vendor shall supply, test, and determine locations of components which are required for proper operation as well as supply, install, test, and certify the performance of the complete system. Vendor qualifications must be acceptable to the AHJ.

6. All tests shall be conducted, documented, and signed by a person in possession of an FCC General Radio Telephone Operators License. All testing personnel shall be certified and authorized by the signal booster manufacturer in the installation and operation of their equipment. Personnel qualifications must be acceptable to the AHJ.

7. The system design shall be based on the Potter ERCES Guardian Series Public Safety Signal Boosters or equivalent UL2524 2nd Edition, NFPA 72, NFPA 1221, IFC and FCC certified to establish standards of quality for materials and performance. The naming of a specific manufacturer or a catalog number does not waiver any requirement or performance of individual components described in the specifications.

8. Assembly and installation of all components of the In-building Two-way Emergency Responder Communication Enhancement System shall comply with all applicable sections of the National Electrical Code.

9. Survivability from attack by fire shall meet requirements of NFPA 72, NFPA 1221, IFC or as required by the local jurisdiction.

10. The system must comply with all applicable sections of the FCC rules. Signal booster shall have FCC certification prior to installation.

11. Antenna isolation shall be maintained between the donor antenna and all inside antennas (DAS) to a minimum of 20dB under all operating conditions.

1.3 SUBMITTALS:

A. General

1. Two (2) copies of all submittals shall be submitted to the Architect/Engineer, AHJ and Radio Network Licensee for review and approval.

2. The contractor must provide a comprehensive list of the proposed equipment, along with a system diagram illustrating the interconnections and functions of the various components, for review and approval by the owner's technical representative. This submittal should include the following items:

   a. Product Data: Submit manufacturer datasheets for the following components:

      1) Bi-Directional Amplifiers (BDA)
      2) Battery Backup Unit (BBU)
      3) Donor and Coverage Antennas
      4) Lightning Suppressor
      5) Coaxial Cable and Connectors
      6) Splitters, Combiners and Couplers

b. Radio Coverage Plan: Submit the following information (provided by AHJ and Radio Network Licensee):
    1) Radio System Specifications
    2) Active frequencies
    3) Donor site locations
    4) Specific building codes enforced
c. Secondary Power Calculations:
d. Initial floorplans
e. Preliminary RF design from industry standard design tool (i.e., iBWave) (new construction)
f. RF Site Survey Results (if applicable, existing building)
g. Acceptance Test Plan (ATP): Submit a proposed ATP including cable testing reports. At a minimum, testing requirements shall be designed to satisfy requirements of the local AHJ and NFPA 72.
h. Warranty Documents:
    1) Submit for all manufactured Components specified in this Section.
    2) Submit DAS Integrator System Warranty.

3. Submittal Requirements at Close Out:
    a. Drawings: Submit as-built drawings indicating:
        1) A final, signed copy of all previously submitted documents reflecting the final, as-built representation, equipment used and details.
        2) Cable routing, splitters, couplers, and coverage antenna final locations.
        3) Active component locations, layout, configuration, and programmed parameters.
    b. Test Reports.
    c. Submit a Certificate of Radio Coverage Compliance signed by a local Fire Marshall, certifying that the system has been installed in accordance with the requirements listed, successfully tested, and found to meet local code requirements and the requirements of this specifications.
    d. Technical Data Sheets: Submit hardware and software manuals for all Active Components.
    e. Warranty Documents:
        1) Submit for all manufactured components specified in this Section.
        2) Submit Contractor's System Warranty.

4. For equipment other than that specified, the contractor shall provide proof that the proposed substitute equipment equals or exceeds the form, feature, function, performance, and quality of the specified equipment.

1.4 WARRANTY:

A. All the main BDA system components, including Signal Boosters, Splitters, Couplers, Coverage Antennas, and Connectors furnished under this contract shall include a warranty from the manufacturer for a period of three (3) years from the date of purchase. All other materials, labor and work performed under this contract shall be free of defects and shall remain so for a period of one (1) year from the date of acceptance. The full cost of materials and labor to correct any defects during these warranty periods shall be included in the installed price of the system.

1.5 MAINTENANCE:

A. All systems shall be operationally tested at least annually to confirm system operation during normal operations or as required by the AHJ.

B. A preventative maintenance schedule shall be provided by the contractor describing the protocol for preventative maintenance. Annual operational tests shall include the following:

1. At least one quantitative DAQ test shall be on each floor. Where the floor area exceeds 128,000 sq. ft., additional quantitative tests shall be performed.
    a. At least every five years systems shall be quantitatively tested to ensure that the system still provides the required DAQ values at the time of installation or as required by the AHJ.
    b. The five-year test shall also confirm that there has been no deviation of coverage of more than 5 percent from the initial installation documentation.
    c. A deviation of more than 5 percent shall result in additional evaluations to determine if any system modifications are required to bring the system into conformance with the coverage required at the time of installation or as required by the AHJ.
    d. The five-year test shall confirm that there have been no changes in the frequencies utilized for the proper operation of the system.
    e. The AHJ can require additional testing if the system fails to operate during normal operations at frequencies shorter than five years or if radio system conditions change.
2. BDA System Functional Measurements/Calculations
    a. Signal boosters shall be tested to verify that the following functional measurements are the same as they were during the initial installation and acceptance or set to optimize the performance of the system:

1) The following measurements shall be taken with an approved spectrum analyzer as well as the settings in the signal booster. The measurements recorded at the initial installation shall be recorded as well.
   (a) Uplink Gain (dB)
   (b) Downlink Gain (dB)
   (c) Uplink Peak Power Level (dBm)
   (d) Downlink Peak Power Level (dBm)
2) Spurious emissions check UL/DL check (Pass/Fail)
3) Isolation between DAS and the Donor Antenna (dB)
4) Incoming Signal Strength from Donor (dBm)

3. FACP Supervision of BDA System / Conditional Testing
   a. The following tests will be performed to ensure the BDA is properly reporting to the Fire Alarm Panel that it is being monitored by:
      1) Simulate AC Power Fault
      2) Simulate Battery Fault
      3) Simulate Donor Antenna Fault
      4) Simulate BDA/DAS Fault
      5) Simulate Annunciator Fault

4. BDA System Visual Inspection
   a. Visual inspections to ensure equipment has not been tampered with or suffered physical damage:
      1) Visual Inspection of all LEDs
      2) Visual Inspection of BDA
      3) Visual Inspection of Battery Enclosure/Battery Terminals
      4) Visual Inspection of DAS/Donor Antenna

5. BDA Power and Battery Testing
   a. Battery testing to ensure batteries are functioning properly:
      1) Verify Battery Voltage
      2) Date on Batteries
      3) Test Battery Under Load
      4) Verify AC Voltage

C. Upon completion of the annual inspection, an annual inspection report shall be submitted to the AHJ and building owner. In addition to the above information, the following shall be submitted in the report:

   1. Property Information:

a. Property name & address
b. Property Manager Contact Information
c. Central Station & Monitoring Company Information

2. Signal Booster Information:
   a. Manufacturer and Model Number
   b. Date of Installation
   c. Location in the building
   d. Applicable Codes/Standards/Local AHJ Requirements from the initial Installation
3. Testing Company Contact Information for Current Test
4. Technician Qualifications:
   a. Technician Name
   b. GROL Callsign
   c. Manufacturer Certification
   d. Date of Manufacturer Certification Received
5. Testing Equipment used for Current Test:
   a. Manufacturer & Model Number of testing equipment
   b. Date of Last Calibration
   c. Name of Calibration Firm
   d. Attached Certificate of Calibration
6. Date of Current test being performed
7. If available, attached copies of the following documents from the initial/acceptance testing:
   a. Grid diagram for each floor, showing tested signal strengths in each grid area
   b. Copies of manufacturer specification sheets for all BDA/DAS systems components, including amplifiers, signal boosters, antennas, coax, couplers, splitters, combiners, and other passive components
   c. Original system design documents
   d. Data sheets for backup battery and charging system
   e. Retransmission agreement(s)
   f. Verification that the signal booster is registered with the FCC
   g. Certification letter stating that the BDA/DAS system has been installed per code and was complete/fully functional at time of installation
8. Radio Networks Retransmitted:

a. System User (AHJ)
b. Radio Networks Amplified
c. Currently Active Control Frequency
d. Tower Location (Address)
e. Tower Location (Latitude, Longitude)
f. FCC Callsigns

9. Donor Antenna(s) Information (at Commissioning & at Current Inspection):

a. Donor Antenna Manufacturer and Model
b. Donor Antenna Gain (dBi)
c. Donor Antenna Azimuth (Deg True)
d. Signal Level Received from Donor Site (dBm)

D. An inspection tag shall be attached to each signal booster in a visible location as determined by the fire code official.

1. The annual inspection tag shall contain the following information:

a. System Location
b. Date of Inspection
c. The inspector's name, signature and their GROL Callsign or FRN Number
d. Inspection Company with Contact Details
e. The tests that were performed
f. Version of Standards/Code for System
g. Results of inspection and test
h. Deficiencies or impairments noted (yes or no)

1.6 APPLICABLE STANDARDS & SPECIFICATIONS:

A. All tasks, encompassing but not restricted to cabling, pathways, support structures, wiring, equipment, installation, craftsmanship, maintenance, and testing, The system shall fully comply with the latest issue of these standards, if applicable.

1. National Fire Protections Association (NFPA)

a. NFPA 72 – National Fire Alarm Code
b. NFPA 1221 – Standard for the Installation, Maintenance, and Use of Emergency Communications Systems
c. NFPA 1225 – Standard for Emergency Services Communications
d. NFPA 70 – National Electric Code (NEC)
e. The National Electrical Safety Code (NESC)

2. Local and State Building Codes

3. All requirements of the local Authority Having Jurisdiction (AHJ)

B. These standards shall be in accordance with the regulations enforced by the county or municipality governing the project's location, encompassing all pertinent local codes, directives, and statutes. In instances of inconsistency or discordance among the aforementioned documents, the contractor is obligated to fulfill the most stringent of the stipulated requirements.

C. Any mandates outlined within the initial-responder code, ordinances, or directives from the Authority Having Jurisdiction (AHJ) shall take precedence over the stipulations delineated herein and must be fully adhered to. It is incumbent upon the Contractor to guarantee that the Distributed Antenna System (DAS) aligns with the pertinent local codes, ordinances, or specifications set forth by the governing body of the public safety network AHJ and radio network license holder.

D. Common abbreviations:

1. ACG: Automatic Gain Control
2. AHJ: Authority Having Jurisdiction
3. ATP: Acceptance Test Plan
4. BDA: Bi-Directional Amplifier
5. BOM: Bill-of-Material
6. DAS: Distributed Antenna System
7. LMR: Land Mobile Radio
8. NFPA: National Fire Protection Association
9. PSN: Public Safety Network
10. SINR: Signal-to-Interference & Noise Ratio
11. SOW: Statement of Work
12. VSWR: Voltage Standing Wave Ratio

1.7 PERFORMANCE REQUIREMENTS:

A. Distributed Antenna System (DAS):

1. Before submitting any documentation, the DAS integrator must verify the accurate frequencies utilized by first responders at the time of submission and commit to ensuring the following signal strengths:
    a. Achieving a minimum Distributed Antenna System Quality (DAQ) of 3.4 or higher, along with an equivalent Signal-to-Interference Noise Ratio (SINR) relevant to the technology, be it analog or digital.
    b. Downlink - Minimum signal strength of -95 dBm across the entire coverage area.
    c. Uplink - Minimum signal strength of -95 dBm received by AHJ Radio System.

OR

d. Alternatively, complying with any signal strength requirements specified by the AHJ.

2. The Distributed Antenna System (DAS) is required to provide coverage across 95% of the entire building, with a focus on achieving coverage in 99% of designated critical areas. These critical areas encompass spaces such as the emergency command center, fire pump room, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical as specified by NFPA 1221 and the Authority Having Jurisdiction (AHJ).

3. The DAS should possess the capability for modifications and upgrades, eliminating the necessity to replace existing hardware or software. Any changes or additions to frequencies within the Public Safety Radio frequency band must be achievable without the requirement for hardware replacement. The DAS design should facilitate future expansion to cover additional public safety radio frequencies.

1.8 APPROVALS:

A. The system shall have the proper listing and/or approval from the following Nationally Recognized Testing Laboratories:

1. UL Underwriters Laboratories Inc.

2. SGS SGS Société Générale de Surveillance SA

PART 2.0 - PRODUCTS

2.1 SPECIFIED BDA MANUFACTURERS:

A. Potter ERCES

2.2 BI-DIRECTIONAL AMPLIFIER (BDA):

A. The BDA shall be a Potter ERCES, Guardian Series, Class A or B Bi-Directional Amplifier, depending on the requirements of the AHJ and Radio Network Licensee.

B. Overview and Features:

1. The system specified shall be based upon Potter ERCES Guardian Series Public Safety UL2524 2nd Edition, compliant with NFPA 72, NFPA 1221, and IFC standards for signal boosters.

2. Equipment shall be available in either Class A or Class B versions, depending on the requirements set by the Authority Having Jurisdiction (AHJ) and the Radio Network Licensee.

3. The Public Safety Signal Booster shall have built-in automatic supervision to detect malfunctions in both the signal booster and battery systems, in accordance with NFPA 1221, NFPA 72, and IFC standards. Non-original equipment manufacturer (OEM) add-ons or modifications are not acceptable to meet this specification.
4. The BDA System must be capable of providing the following alarms to be monitored by the fire alarm system:
    a. Loss of Normal AC Power
    b. Low Battery Capacity
    c. Battery Charger Failure
    d. Signal Source Malfunction (Donor Antenna Disconnection)
    e. Active RF Malfunction
    f. System Component Failure
5. All signal boosters and other active system components must hold FCC certification prior to installation. The FCC ID of the equipment must be visibly displayed on the product, adhering to FCC requirements.
6. Signal Boosters are required to feature oscillation suppression circuitry to safeguard the outside public safety radio network in the event of signal booster system malfunction or other factors that could result in the signal booster oscillating.
7. Signal Boosters are required to incorporate an uplink noise suppression function to eliminate uplink noise during standby periods, wherein no radio transmission occurs from within a building. Systems generating any detectable level of uplink noise during standby are deemed unacceptable.
8. Signal booster must have uplink and downlink squelch per channel.
9. The Signal Booster gain should be rated at a minimum of 80dB with a tolerance of +/- 2.0dB, and its gain should be adjustable within a minimum range of 25dB. The system gain is to be configured and documented during the final system test.
10. The signal booster system's maximum propagation delay must be adjustable within the booster, meeting system requirements or specifications set by the AHJ. The signal booster should provide filter delay options, ensuring that the maximum propagation delay falls within a range of <1.5µS to 61.5µS.
11. The Signal Booster must not generate more than a maximum of 5dB noise across its published operable uplink gain range.
12. Signal Boosters are required to have an uplink noise suppression function to eliminate uplink noise during standby (i.e., when there is no radio transmission from within a building). Signal booster systems producing any measurable level of uplink noise during standby shall be deemed unacceptable.

13. Any external filters, duplexers, power supplies, or non-OEM additions or modifications to the original equipment are not acceptable, except when technically required, provided it does not violate the UL2524 2nd edition certification. If needed, external filters should be manufactured or certified by the original equipment manufacturer.

14. All components of the signal booster must be enclosed in a waterproof enclosure approved for type-4 applications. The enclosures are to be painted red and labeled externally as required by the AHJ.

15. The secondary power supplies, battery chargers, and system monitoring must adhere to full compliance with UL2524 2nd Edition, NFPA 72, NFPA 1221, and IFC standards. The signal booster is required to incorporate both primary and secondary power supplies housed in a waterproof enclosure approved for type-4 applications.

2.3 SYSTEM COMPONENTS:

C. Compatible BDA Components:

1. Battery Backup Unit (BBU)
    a. Newmar PE-24V-240-55AH-UL2524
    b. Newmar PE-24V-240-100AH-UL2524
    c. Newmar PE-12V-120-55AH-UL2524
    d. Newmar PE-12V-120-100AH-UL2524
2. Remote Annunciator
    a. Newmar AP-8000C
3. Indoor Antennas
    a. 222W
    b. 535W
    c. 540W
4. Yagi Directional Donor Antenna
    a. DONOR-698-960-8
5. Air Dielectric, Plenum Rated Cable
    a. COAX-PL-FT
6. Connectors
    a. NMP
    b. NFP

7. Couplers
    a. COUP-698-2500-6
    b. COUP-698-2500-10
8. Splitters
    a. SPLIT-698-2700-2
    b. SPLIT-698-2700-3
    c. SPLIT-698-2700-4
9. Tappers
    a. TAP-137-960-3
    b. TAP-137-960-5
    c. TAP-137-960-6
    d. TAP-137-960-8
    e. TAP-137-960-10
    f. TAP-137-960-13
    g. TAP-137-960-15
    h. TAP-137-960-20
    i. TAP-137-960-30
10. Attenuators
    a. ATNR-5
    b. ATNR-10
    c. ATNR-20
11. Jumpers
    a. JUMP-NMNM-3
    b. JUMP-NMNM-6
    c. JUMP-NMNF-3
    d. JUMP-NMNF-6

2.4 EQUIPMENT & MATERIALS:

A. All equipment and components shall be new, and of the manufacturer's current model. The materials, appliances, equipment, and devices shall be tested and listed for their intended purpose by a recognized national listing testing laboratory.

B. All equipment and components shall be installed in strict compliance with the manufacturer's recommendations as indicated in the installation manuals and wiring diagrams for the system.

C. All equipment attached to walls and ceiling shall be securely fastened. Ceiling mounted devices shall not be supported solely by suspended ceilings. A back box shall be used for mounting all equipment when required. A listed and compatible back box shall be used on all outdoor devices, or those devices installed in locations subject to moisture.

CONDUIT & WIRE:

A. Conduit:

1. The conduit or raceway shall be installed in accordance with the National Electrical Code, state, and local requirements.
2. All conduit and raceway shall be listed and/or approved by a recognized national testing laboratory.
3. Conduit size for (1) ½" coaxial cable is 1-½" minimum.
4. Minimum conduit size for (2) separate ½" coaxial cables is required to be 2".
5. Conduit may only enter the fire alarm control panel, power supply, annunciator, and other system cabinets through the pre-punched knockouts provided by the system manufacturer.

B. Wire:

1. All fire alarm wiring shall be new.
2. Wiring shall be installed in accordance with local, state, and national codes and as recommended by the manufacturer of the fire alarm system.
3. All wire and cable shall be listed and/or approved by a recognized national testing laboratory for its intended purpose.
4. Coaxial cable must be independently supported every 4 feet. Coaxial cable is not to be bundled with other systems.
5. Do not exceed manufacturer's listed minimum bend radius for coaxial cable.
6. In areas where the coaxial cable is subject to mechanical damage, coaxial cable shall be protected from physical damage with the use of conduit or armored cable.

C. Terminal Boxes, Junction Boxes, and Cabinets

1. All terminal boxes, junction boxes, and accessory cabinets shall be listed for their intended purpose.

2. The minimum junction box size for use with coaxial cable shall be 16” x 16” x 6”.

PART 3.0 - EXECUTION

3.1 INSTALLATION:

A. The entire installation shall be in accordance with NFPA 72, NFPA 70 (NEC), state and local codes, and meet the requirements of the local Authorities Having Jurisdiction.

B. The installation shall be in accordance with the manufacturer’s recommended practices and installation instructions.

C. BDA Requirements:

1. The primary power source of the BDA shall be supplied from a dedicated twenty (20) ampere branch circuit and comply with NFPA 70 (NEC), NFPA 72 and NFPA 1221.

   a. The signal booster shall be equipped with a secondary source of power. The secondary source of power shall be a battery system with a dedicated battery charger powered by a separate, dedicated twenty (20) ampere branch circuit. The secondary power supply shall power on automatically when the primary power source is lost. The battery system shall automatically charge in the presence of external power input. Battery charger and all other electronic components must be fully enclosed in a waterproof Type-4 approved enclosure. Batteries shall be enclosed in a NEMA-4 rated enclosure. External UPS (Uninterruptable Power Supplies) are not acceptable.

   b. The secondary source of power shall be capable of operating the in-building two-way emergency responder communication enhancement system for a period of at least 12 hours, up to 24-hour battery backup may be required based on local codes. The DAS integrator shall confirm will the local AHJ.

2. All installed systems will need prior written approval from the FCC license holder of the systems being re-amplified and must meet their established criteria for installation prior to the system installation.

3. Installed systems shall be registered with the FCC signal booster registry where required.

D. Cable and Equipment:

1. All conduit, junction boxes, and supports shall be concealed in finished areas and may be exposed in unfinished areas.

2. Installation Process: The installation process encompasses the delivery, unloading, placement, securing to walls, floors, ceilings, or other structures, and where necessary, firestop penetration, interconnecting wiring of system components, equipment alignment and adjustments, and any other work, whether expressly specified herein or not, essential for achieving a fully operational Distributed Antenna System (DAS).

3. Installation Obligations: Throughout the installation phase, and up until the final acceptance date, the integrator is obligated to safeguard both finished and unfinished work against damage and loss. In the event of any damage or loss, the integrator shall promptly replace or repair the affected work at no cost to the owner.

4. Equipment Mounting: All equipment must be securely mounted on equipment racks or walls. Wall-mounted equipment should be affixed over 1/2-inch fire-rated plywood securely attached to the wall.

5. Cable Support and Tray Usage: Cables must be appropriately supported using dedicated hangers or brackets. The use of cable trays is permissible only if they are specifically designed for low voltage applications and have received approval from the owner.

6. Fastening and Support Criteria: Fastening and support mechanisms must be robust enough to handle their loads, ensuring a safety factor of at least three.

7. Secure Placement: All boxes, equipment, etc., must be securely positioned to be plumb, level, and square.

8. Considerations for Installation: In installing equipment and cables, careful consideration must be given to both operational efficiency and overall aesthetic factors. Antennas should be centered and aligned with other ceiling-mounted devices.

9. Handling of Coax Cables: All coax cables must be handled according to the manufacturer's guidelines. Transmission line cables must adhere to minimum bending radius specifications, and any kinked or excessively bent sections during installation are deemed unusable. Damaged sections must be removed, and new sections installed using appropriate splice methods, ultimately meeting testing requirements and manufacturer specifications.

10. Separation from Electrical Cabling: Radio communications cabling must not be grouped with electrical cabling; it may only share sleeves and raceways with other low voltage data and communications cables.

    a. Connections between cables and other antenna components must employ N-Type premium connectors. No coax cable splicing is allowed.

b. All power dividers must be securely mounted by bolting to a solid surface or suspending within 4 inches of each connector termination at the power divider. The transmission lines connecting to the device should follow the shortest possible path.

E. Grounding

1. Grounding Procedures for Signal Optimization: In order to mitigate issues arising from improper grounding and ensure optimal signal-to-noise ratios, adherence to the following grounding procedures shall be adhered to:

a. System Ground: A primary "system ground" must be established for the entire system, serving as the central point for all grounding conductors in that specific area. This system ground should comprise a sufficiently sized copper bar capable of accommodating all secondary ground conductors. Additionally, an extension of this ground should be connected to the building's lightning protection system, following the guidance of the on-site electrical engineer.

b. Primary System Ground Connection: A copper conductor, with a maximum total resistance of 0.1 Ohms, must establish a connection between the primary system ground bar and the primary system ground ring.

c. Secondary System Grounding Conductors: From all racks, radio consoles, and under grounded radio equipment in each area, secondary system grounding conductors must be provided, connecting to the primary system grounding point for that area. Each of these grounding conductors should have a maximum total resistance of 0.1 Ohms.

d. AC Neutral Conductor Exclusion: Under no circumstances should the AC neutral conductor, whether in the power panel or receptacle outlets, be utilized as a grounding point for the Distributed Antenna System (DAS).

e. General Grounding Practices: Given the numerous potential variations in grounding systems, it is the integrator's responsibility to adhere to sound engineering practices as outlined above. Deviations from these practices should only occur when necessary to minimize crosstalk, maximize signal-to-noise ratios, and reduce interference in the radio systems.

3.2 ACCEPTANCE TEST:

A. All tests shall be conducted in accordance with NFPA 72/NFPA 1221/Local AHJ Requirements.

B. The contractor shall complete the acceptance testing as prescribed in the approved Acceptance Test Plan (ATP) submittal.

C. All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radio Operator License.

D. All test records along with system diagrams, iBwave design, equipment specifications, user manuals, RF link budget calculations, battery backup calculation and other design data shall be submitted upon completion of the project, and as required by the AHJ.

E. Persons conducting BDA acceptance tests shall be knowledgeable in BDA systems. This is verified by the proper training and recognition from either the factory, NICET, State or locally certified, or trained by a company that is listed by a national testing laboratory.

F. Acceptance Test Procedure: Following the completion of the installation, a comprehensive radio system test must be conducted to ensure that two-way radio coverage on each floor of the building attains the minimum acceptable metrics required by the AHJ.

1. In Absence of AHJ Requirements:
    a. If there are no specific requirements outlined by the Authority Having Jurisdiction (AHJ), the minimum signal strength requirement shall be as follows:
        1) Achieving a minimum Distributed Antenna System Quality (DAQ) of 3.4 or higher, along with an equivalent Signal-to-Interference Noise Ratio (SINR) relevant to the technology, be it analog or digital.
        2) Downlink: Minimum signal strength of -95 dBm across the entire coverage area.
        3) Uplink: Minimum signal strength of -95 dBm received by AHJ Radio System.
    b. Passing Criteria for Floors:
        1) A minimum of 95% of the designated test areas on each floor must meet the specified criteria.
        2) A minimum of 99% of the critical areas on each floor must meet the specified criteria.

G. The acceptance test procedure is outlined as follows:

1. Each floor of the building should be partitioned into a grid consisting of 20 or more approximately equal areas.
2. Equipment used to conduct an in-building RF signal strength survey shall have a current certificate of calibration.
3. Approved In-Building RF Signal Testing Equipment:
    a. PCTEL IBflex - Public Safety Network Testing Solution
    b. RF Spectrum Analyzer

c. Portable Radio of the latest brand and model utilized by the agency, communicating through the agency's radio communications system.
d. Other testing tools required by the local AHJ.

4. Test Location Selection: Measurements are to be performed starting in the center of the grid area.
    a. Measurement shall use a consistent approach to the location and orientation of the antenna of the measuring device – as close as possible to the usage by the radio users/emergency responders.
    b. If multiple measurements are taken in a grid area, these results shall be averaged.
5. Amplifier Gain Measurement: Gain values of all amplifiers must be measured, and the results should be documented on as-built drawings and Operation & Maintenance (O&M) manuals for verification during annual tests.
6. FCC Compliance:
    a. Verification of FCC Certification: Ensure that all installed equipment possesses an FCC Certification.
    b. Spurious Oscillations Check: During installation, a spectrum analyzer or suitable test equipment is employed to ensure that no spurious oscillations are generated by the signal booster.
    c. DAS Commissioning and Noise Level Verification: Upon commissioning of the DAS system, the DAS integrator collaborates with the local Public Safety radio office, providing them with an opportunity to assess the noise level generated by the DAS on the county system. Verification is performed to confirm that the noise level is within acceptable limits as determined by the regulatory agency.
7. Isolation Testing: Conduct testing to validate a minimum isolation of BDA Gain plus 20 dB between the donor antenna and the distribution antennas.
8. Documentation:
    a. Frequency License Holder Approval: Verification that there is a signed copy of the retransmission agreement for all frequencies and modulation technologies being enhanced by the ERCES.
    b. Minimum qualifications of personnel: Verify credentials of testing personnel prior to the acceptance test.
9. Near Far Testing: Verification that testing personnel performed near/far testing of the ERCES, where applicable.

10. Mounting of Donor Antenna: Donor antenna (where provided) is of the type listed in the submittal package, it is pointed in the proper direction, it has not been blocked by other trades equipment and it is permanently affixed to the structure, or if a movable sled was approved that proper signage has been attached.

3.3 OPERATOR INSTRUCTION:

A. The manufacturer–trained representative shall instruct and demonstrate to the building owner the operation of all system components. An operator's manual shall be provided and kept with the BDA for future reference. A drawing or list shall be provided to the building owner detailing the device locations, addresses, and programming of each system device.

+ + END OF SECTION + +

NO TEXT ON THIS PAGE

SECTION 16900

CABLE AND CONDUIT SCHEDULE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The cable and conduit schedule lists conduit number, size and type, cable quantity and size from/to destinations, circuit purpose and remarks.

B. All conduits and wiring shall be furnished and installed under this Contract, unless specifically noted otherwise.

C. The conduit numbering system consists of two parts separated by hyphen. First part is the equipment identification number. The second part is the individual conduit identification number. The individual conduit identification number may be presented in a 2- or 3-digit format (for example, 01 and 001) and represents the same conduit.

D. The definition of the term conduit shall include all types of raceway provided under this Contract.

E. In all cases where the word install or installed refers to conduit it shall mean install all conduit, raceways, fittings, supports, boxes and appurtenances. In addition it shall include all grounding and bonding. Drag lines are to be pulled upon completion of each raceway.

F. Where install or installed refers to cable it shall include pulling the cable and testing the cable for insulation resistance, continuity and absence from grounds, as well as terminating all conductors and testing for proper connection.

G. In general, the conduit and cable schedules do not indicate lighting and receptacle circuits, as well as some of the other cable and conduit to be provided under this Contract. The Contractor is advised to refer to the Specifications and Drawings for the additional conduit and cable requirements.

H. Conform to the specifications requirements for Conduit and Cable Sections 16131 and 16131 - Electric Conduit System, and Sections 16121 and 16121E - Electric Wire and Cable.

I. The conduit and cable schedule begins on the following page.

J. Refer to the Contract Drawings for specific type of conduit installed. Should there be a conflict between the type of conduit indicated on the Drawings and the following specifications schedule type, the Drawings shall take precedence.

+ + END OF SECTION + +

SECTION 16900 - CABLE AND CONDUIT SCHEDULE - AERATION BLOWER BUILDING

CONDUIT NO.	SIZE	TYPE	FROM	TO	CABLE & SIZE	PURPOSE	REMARKS
AB-MVA-001	4"	PVCRGS	MAIN UNIT SUBSTATION	MVABP-A07 MAIN	4#500 MCM + #250 MCM GND	4160V POWER	
AB-MVA-002	4"	PVCRGS	MAIN UNIT SUBSTATION	MVABP-A07 MAIN	4#500 MCM + #250 MCM GND	4160V POWER	
AB-MVA-003	4"	PVCRGS	MAIN UNIT SUBSTATION	MVABP-A07 MAIN	4#500 MCM + #250 MCM GND	4160V POWER	
AB-MVA-004	4"	PVCRGS	MAIN UNIT SUBSTATION	MVABP-A07 MAIN	4#500 MCM + #250 MCM GND	4160V POWER	
AB-MVA-005	4"	PVCRGS	MAIN UNIT SUBSTATION	AERATION BLOWER BUILDING, PB-MV-1 - SPARE	DRAG LINES		
AB-MVA-006	4"	PVCRGS	MAIN UNIT SUBSTATION	AERATION BLOWER BUILDING, PB-MV-1 - SPARE	DRAG LINES		
AB-MVA-007	4"	PVCRGS	MAIN UNIT SUBSTATION	AERATION BLOWER BUILDING, PB-MV-1 - SPARE	DRAG LINES		
AB-MVA-008	4"	PVCRGS	MAIN UNIT SUBSTATION	AERATION BLOWER BUILDING, PB-MV-1 - SPARE	DRAG LINES		
AB-MVB-001	4"	PVCRGS	MAIN UNIT SUBSTATION	MVABP-B07 MAIN	4#500 MCM + #250 MCM GND	4160V POWER	
AB-MVB-002	4"	PVCRGS	MAIN UNIT SUBSTATION	MVABP-B07 MAIN	4#500 MCM + #250 MCM GND	4160V POWER	
AB-MVB-003	4"	PVCRGS	MAIN UNIT SUBSTATION	MVABP-B07 MAIN	4#500 MCM + #250 MCM GND	4160V POWER	
AB-MVB-004	4"	PVCRGS	MAIN UNIT SUBSTATION	MVABP-B07 MAIN	4#500 MCM + #250 MCM GND	4160V POWER	
AB-MVB-005	4"	PVCRGS	MAIN UNIT SUBSTATION	AERATION BLOWER BUILDING, PB-MV-1 - SPARE	DRAG LINES		
AB-MVB-006	4"	PVCRGS	MAIN UNIT SUBSTATION	AERATION BLOWER BUILDING, PB-MV-1 - SPARE	DRAG LINES		
AB-MVB-007	4"	PVCRGS	MAIN UNIT SUBSTATION	AERATION BLOWER BUILDING, PB-MV-1 - SPARE	DRAG LINES		
AB-MVB-008	4"	PVCRGS	MAIN UNIT SUBSTATION	AERATION BLOWER BUILDING, PB-MV-1 - SPARE	DRAG LINES		
AB-ABB1-001	3"	PVCRGS	MVABP-A07#A1	SS-HHWS1	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB1-002	3"	RGS	SS-HHWS1	HHWS1 CONTROLLER	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB1-003	3"	RGS	HHWS1 CONTROLLER	HHWS1	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB2-001	3"	RGS	MVABP-A07#A2	SS-HHWS2	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB2-002	3"	RGS	SS-HHWS2	HHWS2 CONTROLLER	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB2-003	3"	RGS	HHWS2 CONTROLLER	HHWS2	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB3-001	3"	RGS	MVABP-A07#A3	SS-HHWS3	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB3-002	3"	RGS	SS-HHWS3	HHWS3 CONTROLLER	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB3-003	3"	RGS	HHWS3 CONTROLLER	HHWS3	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB4-001	3"	RGS	MVABP-A07#A4	SS-HHWS4	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB4-002	3"	RGS	SS-HHWS4	HHWS4 CONTROLLER	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB4-003	3"	RGS	HHWS4 CONTROLLER	HHWS4	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB5-001	3"	RGS	MVABP-A07#A5	SS-HHWS5	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB5-002	3"	RGS	SS-HHWS5	HHWS5 CONTROLLER	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB5-003	3"	RGS	HHWS5 CONTROLLER	HHWS5	3#2 AWG + #6 AWG GND	4160V POWER	
AB-ABB6-001	3"	RGS	MVABP-A07#A6	FUTURE SS-HHWS6	DRAG LINES		
AB-ABB6-002	3"	RGS	FUTURE SS-HHWS6	HHWS6 CONTROLLER	DRAG LINES		
AB-PTRA4-001	4"	PVCRGS	MVABP-A07#A4	TR-A4 PRIMARY DISCONNECT SWITCH	3#1/0 AWG + #6 AWG GND	480V POWER	
AB-PTRA4-002	4"	PVCRGS	MVABP-A07#A4	TR-A4 PRIMARY DISCONNECT SWITCH	3#1/0 AWG + #6 AWG GND	480V POWER	
AB-PTRB4-001	4"	PVCRGS	MVABP-B07#B4	TR-B4 PRIMARY DISCONNECT SWITCH	3#1/0 AWG + #6 AWG GND	480V POWER	
AB-PTRB4-002	4"	PVCRGS	MVABP-B07#B4	TR-B4 PRIMARY DISCONNECT SWITCH	3#1/0 AWG + #6 AWG GND	480V POWER	
AB-STRA4-001	4"	PVCRGS	TR-A4 SECONDARY	LVABP-A4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-002	4"	PVCRGS	TR-A4 SECONDARY	LVABP-A4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-003	4"	PVCRGS	TR-A4 SECONDARY	LVABP-A4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-004	4"	PVCRGS	TR-A4 SECONDARY	LVABP-A4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-005	4"	PVCRGS	TR-A4 SECONDARY	LVABP-A4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-006	4"	PVCRGS	TR-A4 SECONDARY	LVABP-A4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-007	4"	PVCRGS	TR-A4 SECONDARY	LVABP-A4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRB4-001	4"	PVCRGS	TR-B4 SECONDARY	LVABP-B4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-002	4"	PVCRGS	TR-B4 SECONDARY	LVABP-B4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-003	4"	PVCRGS	TR-B4 SECONDARY	LVABP-B4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-004	4"	PVCRGS	TR-B4 SECONDARY	LVABP-B4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-005	4"	PVCRGS	TR-B4 SECONDARY	LVABP-B4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-006	4"	PVCRGS	TR-B4 SECONDARY	LVABP-B4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-STRA4-007	4"	PVCRGS	TR-B4 SECONDARY	LVABP-B4, MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCA-001	4"	RGS	LVABP-A4#1A	LVABP-MCC-A MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCA-002	4"	RGS	LVABP-A4#1A	LVABP-MCC-A MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCA-003	4"	RGS	LVABP-A4#1A	LVABP-MCC-A MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCA-004	4"	RGS	LVABP-A4#1A	LVABP-MCC-A MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCA-005	4"	RGS	LVABP-A4#1A	LVABP-MCC-A MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCA-006	4"	RGS	LVABP-A4#1A	LVABP-MCC-A MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCA-007	4"	RGS	LVABP-A4#1A	LVABP-MCC-A MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCB-001	4"	RGS	LVABP-B4#1B	LVABP-MCC-B MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCB-002	4"	RGS	LVABP-B4#1B	LVABP-MCC-B MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCB-003	4"	RGS	LVABP-B4#1B	LVABP-MCC-B MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCB-004	4"	RGS	LVABP-B4#1B	LVABP-MCC-B MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCB-005	4"	RGS	LVABP-B4#1B	LVABP-MCC-B MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCB-006	4"	RGS	LVABP-B4#1B	LVABP-MCC-B MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-MCCB-007	4"	RGS	LVABP-B4#1B	LVABP-MCC-B MAIN	4#350 MCM + #1/0 AWG GND	480V POWER	
AB-P2-001	3/4"	RGS	LVABP-MCC-A#1A	VFD-P2	3#12 AWG + #12 AWG GND	480V POWER	
AB-P2-002	3/4"	RGS	VFD-P2	P-2	3#12 AWG + #12 AWG GND	480V POWER	
AB-P4-001	3/4"	RGS	LVABP-MCC-A#2A	VFD-P4	3#12 AWG + #12 AWG GND	480V POWER	
AB-P4-002	3/4"	RGS	VFP-P4	P-4	3#12 AWG + #12 AWG GND	480V POWER	
AB-WTWHP2-001	1 1/4"	RGS	LVABP-MCC-A#3A	SW-WTWHP2	3#4 AWG + #8 AWG GND	480V POWER	
AB-WTWHP2-002	1 1/4"	RGS	SW-WTWHP2	WTWHP-2	3#4 AWG + #8 AWG GND	480V POWER	
AB-ATWHP1-001	1 1/4"	RGS	LVABP-MCC-A#4A	SW-ATWHP1	3#1 AWG + #8 AWG GND	480V POWER	
AB-ATWHP1-002	1 1/4"	RGS	SW-ATWHP1	ATWHP-1	3#1 AWG + #8 AWG GND	480V POWER	
AB-ATWHP3-001	1 1/4"	RGS	LVABP-MCC-A#5A	SW-ATWHP3	3#1 AWG + #8 AWG GND	480V POWER	
AB-ATWHP3-002	1 1/4"	RGS	SW-ATWHP3	ATWHP-3	3#1 AWG + #8 AWG GND	480V POWER	
AB-EF1-001	3/4"	RGS	LVABP-MCC-A#6A	SW-EF1	3#10 AWG + #10 AWG GND	480V POWER	
AB-EF1-002	3/4"	RGS	SW-EF1	EF-1	3#10 AWG + #10 AWG GND	480V POWER	
AB-EF2-001	3/4"	RGS	LVABP-MCC-A#7A	SW-EF2	3#10 AWG + #10 AWG GND	480V POWER	
AB-EF2-002	3/4"	RGS	SW-EF2	EF-2	3#10 AWG + #10 AWG GND	480V POWER	
AB-EF3-001	3/4"	RGS	LVABP-MCC-A#8A	SW-EF3	3#10 AWG + #10 AWG GND	480V POWER	
AB-EF3-002	3/4"	RGS	SW-EF3	EF-3	3#10 AWG + #10 AWG GND	480V POWER	
AB-ATSLV1A-001	4"	RGS	LVABP-MCC-A#17A	ATS-LV1 - NORMAL SOURCE	4#600 MCM + #1/0 AWG GND	480V POWER	
AB-ATSLV1A-002	4"	RGS	LVABP-MCC-A#17A	ATS-LV1 - NORMAL SOURCE	4#600 MCM + #1/0 AWG GND	480V POWER	
AB-P1-001	3/4"	RGS	LVABP-MCC-B#1B	VFD-P1	3#12 AWG + #12 AWG GND	480V POWER	
AB-P1-002	3/4"	RGS	VFD-P1	P-1	3#12 AWG + #12 AWG GND	480V POWER	
AB-P3-001	3/4"	RGS	LVABP-MCC-B#2B	VFD-P3	3#12 AWG + #12 AWG GND	480V POWER	
AB-P3-002	3/4"	RGS	VFD-P3	P-3	3#12 AWG + #12 AWG GND	480V POWER	
AB-WTWHP1-001	1 1/4"	RGS	LVABP-MCC-B#3B	SW-WTWHP1	3#4 AWG + #8 AWG GND	480V POWER	
AB-WTWHP1-002	1 1/4"	RGS	SW-WTWHP1	WTWHP-1	3#4 AWG + #8 AWG GND	480V POWER	
AB-WTWHP3-001	3/4"	RGS	LVABP-MCC-B#4B	SW-WTWHP3	3#8 AWG + #10 AWG GND	480V POWER	
AB-WTWHP3-002	3/4"	RGS	SW-WTWHP3	WTWHP-3	3#8 AWG + #10 AWG GND	480V POWER	
AB-ATWHP2-001	1 1/4"	RGS	LVABP-MCC-B#5B	SW-ATWHP2	3#1 AWG + #8 AWG GND	480V POWER	
AB-ATWHP2-002	1 1/4"	RGS	SW-ATWHP2	ATWHP-2	3#1 AWG + #8 AWG GND	480V POWER	
AB-EF4-001	3/4"	RGS	LVABP-MCC-B#6B	SW-EF4	3#10 AWG + #10 AWG GND	480V POWER	
AB-EF4-002	3/4"	RGS	SW-EF4	EF-4	3#10 AWG + #10 AWG GND	480V POWER	
AB-EF5-001	3/4"	RGS	LVABP-MCC-B#7B	SW-EF5	3#10 AWG + #10 AWG GND	480V POWER	
AB-EF5-002	3/4"	RGS	SW-EF5	EF-5	3#10 AWG + #10 AWG GND	480V POWER	
AB-ATSLV1B-001	4"	RGS	LVABP-MCC-B#17B	ATS-LV1 - EMERGENCY SOURCE	4#600 MCM + #1/0 AWG GND	480V POWER	

SECTION 16900 - CABLE AND CONDUIT SCHEDULE - AERATION BLOWER BUILDING

CONDUIT NO.	SIZE	TYPE	FROM	TO	CABLE & SIZE	PURPOSE	REMARKS
AB-ATSLV1B-002	4"	RGS	LVABP-MCC-B#17B	ATS-LV1 - EMERGENCY SOURCE	4#600 MCM + #1/0 AWG GND	480V POWER	
AB-DBLVP1-001	4"	RGS	ATS-LV1 - LOAD SIDE	LVP-1 MAIN BREAKER	4#600 MCM + #1/0 AWG GND	480V POWER	
AB-DBLVP1-002	4"	RGS	ATS-LV1 - LOAD SIDE	LVP-1 MAIN BREAKER	4#600 MCM + #1/0 AWG GND	480V POWER	
AB-BCA-001	2 1/2"	RGS	LVP-1#1	BATTERY CHARGER A	4#3/0 AWG +#6 AWG GND	480V POWER	
AB-BCA-002	2 1/2"	RGS	BATTERY CHARGER A	BANK A	4#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-BCB-001	2 1/2"	RGS	LVP-1#2	BATTERY CHARGER B	4#3/0 AWG +#6 AWG GND	480V POWER	
AB-BCB-002	2 1/2"	RGS	BATTERY CHARGER B	BANK B	4#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-BBA-001	2"	RGS	BATTERY BANK A	SW-BANKA	3#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-BBA-002	2"	RGS	SW-BANKA	BANK A	3#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-BBB-001	2"	RGS	BATTERY BANK B	SW-BANKB	3#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-BBB-002	2"	RGS	SW-BANKB	BANK B	3#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-BANKA2-001	2"	RGS	BANK A#2	DCATS-A	3#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-BANKA3-001	2"	RGS	BANK A#3	DCATS-B	3#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-BANKB2-001	2"	RGS	BANK B#2	DCATS-A	3#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-BANKB3-001	2"	RGS	BANK B#3	DCATS-B	3#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-DCATSA-001	2"	RGS	DCATS-A	DC BANK-A	3#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-DCATSB-001	2"	RGS	DCATS-B	DC BANK-B	3#3/0 AWG +#6 AWG GND	125V DC POWER	
AB-DCBA1-001	2"	RGS	DC BANK A#1	MVABP-A07 INTERNAL DC CONTROL BUS	2#10 AWG + #10 AWG GND (600V, SOLID)	125V DC POWER	
AB-DCBA2-001	2"	RGS	DC BANK A#2	MVABP-B07 INTERNAL DC CONTROL BUS	2#10 AWG + #10 AWG GND (600V, SOLID)	125V DC POWER	
AB-DCBB1-001	2"	RGS	DC BANK B#1	MVABP-A07 INTERNAL DC CONTROL BUS	2#10 AWG + #10 AWG GND (600V, SOLID)	125V DC POWER	
AB-DCBB2-001	2"	RGS	DC BANK B#2	MVABP-B07 INTERNAL DC CONTROL BUS	2#10 AWG + #10 AWG GND (600V, SOLID)	125V DC POWER	
AB-EF6-001	3/4"	RGS	PP1#14	SS-EF6	2#12 AWG + #12 AWG GND	120V POWER	
AB-EF6-002	3/4"	RGS	SS-EF6	EF-6	2#12 AWG + #12 AWG GND	120V POWER	
AB-EF7-001	3/4"	RGS	PP1#16	SS-EF7	2#12 AWG + #12 AWG GND	120V POWER	
AB-EF7-002	3/4"	RGS	SS-EF7	EF-7	2#12 AWG + #12 AWG GND	120V POWER	
AB-EF8-001	3/4"	RGS	PP1#11	SPRING-TIMER & TIME CLOCK	2#12 AWG + #12 AWG GND	120V POWER	
AB-EF8-002	3/4"	RGS	SPRING-TIMER & TIME CLOCK	EF-8	2#12 AWG + #12 AWG GND	120V POWER	
AB-AC1A-001	3/4"	RGS	PP1#24,26	SW-AC1A	2#12 AWG + #12 AWG GND	120V POWER	
AB-AC1A-002	3/4"	RGS	SW-AC1A	AC-1A	2#12 AWG + #12 AWG GND	120V POWER	
AB-AC1B-001	3/4"	RGS	PP1#23,25	SW-AC1B	2#12 AWG + #12 AWG GND	120V POWER	
AB-AC1B-002	3/4"	RGS	SW-AC1B	AC-1B	2#12 AWG + #12 AWG GND	208V POWER	
AB-AC2A-001	3/4"	RGS	PP1#15,17	SW-AC2A	2#12 AWG + #12 AWG GND	208V POWER	
AB-AC2A-002	3/4"	RGS	SW-AC2A	AC-2A	2#12 AWG + #12 AWG GND	208V POWER	
AB-AC2B-001	3/4"	RGS	PP1#19,21	SW-AC2B	2#12 AWG + #12 AWG GND	208V POWER	
AB-AC2B-002	3/4"	RGS	SW-AC2B	AC-2B	2#12 AWG + #12 AWG GND	208V POWER	
AB-AC3-001	3/4"	RGS	PP1#33,35	SW-AC3	2#12 AWG + #12 AWG GND	208V POWER	
AB-AC3-002	3/4"	RGS	SW-AC3	AC-3	2#12 AWG + #12 AWG GND	208V POWER	
AB-GDP1-001	3/4"	RGS	PP1#31	GDP-1	2#12 AWG + #12 AWG GND	120V POWER	
AB-GDP1-002	3/4"	RGS	GDP-1	GDP-1 REMOTE ALARM	2#12 AWG + #12 AWG GND	120V POWER	
AB-GDP2-001	3/4"	RGS	PP1#29	GDP-2	2#12 AWG + #12 AWG GND	120V POWER	
AB-GDP2-002	3/4"	RGS	GDP-2	GDP-2 REMOTE ALARM	2#12 AWG + #12 AWG GND	120V POWER	
AB-AMP1-001	3/4"	RGS	PP1#27	AMP-1	2#12 AWG + #12 AWG GND	120V POWER	
AB-CRAC1-001	1 1/4"	RGS	LVP-1#3	ECRAC-1 & CU-1	3#4 AWG + #8 AWG GND	480V POWER	
AB-CU1-001	3/4"	RGS	ECRAC-1	CU-1	3#12 AWG + #12 AWG GND	480V POWER	
AB-CRAC2-001	1 1/4"	RGS	LVP-1#4	ECRAC-2 & CU-2	3#4 AWG + #8 AWG GND	480V POWER	
AB-CU2-001	3/4"	RGS	ECRAC-2	CU-2	3#12 AWG + #12 AWG GND	480V POWER	
AB-ERV1-001	3/4"	RGS	PP2#40,42	SW-ERV1	2#12 AWG + #12 AWG GND	208V POWER	
AB-ERV1-002	3/4"	RGS	SW-ERV1	ERV-1	2#12 AWG + #12 AWG GND	208V POWER	
AB-LPP2-001	1 1/2"	RGS	LVP-1#12	PANEL LPP2	4#1 AWG + #8 AWG GND	480V POWER	
AB-ATH-001	1 1/4"	RGS	LPP2#2,4	PANEL ATH	4#4 AWG + #8 AWG GND	480V POWER	
AB-LIFT-001	2 1/2"	RGS	LVP-1#13	PANEL LIFT	4#4/0 AWG + #4 AWG GND	480V POWER	
AB-HST1-001	1"	RGS	LIFT#1,3,5	SW-HST1	3#10 AWG + #10 AWG GND	480V POWER	
AB-HST1-002	1"	RGS	SW-HST1	HST1	3#10 AWG + #10 AWG GND	480V POWER	
AB-HST2-001	1"	RGS	LIFT#2,4,6	SW-HST2	3#10 AWG + #10 AWG GND	480V POWER	
AB-HST2-002	1"	RGS	SW-HST2	HST2	3#10 AWG + #10 AWG GND	480V POWER	
AB-HST3-001	1"	RGS	LIFT#7,9,11	SW-HST3	3#10 AWG + #10 AWG GND	480V POWER	
AB-HST3-002	1"	RGS	SW-HST3	HST3	3#10 AWG + #10 AWG GND	480V POWER	
AB-HST4-001	1"	RGS	LIFT#8,10,12	SW-HST4	3#10 AWG + #10 AWG GND	480V POWER	
AB-HST4-002	1"	RGS	SW-HST4	HST4	3#10 AWG + #10 AWG GND	480V POWER	
AB-HST5-001	1"	RGS	LIFT#13,15,17	SW-HST5	3#10 AWG + #10 AWG GND	480V POWER	
AB-HST5-002	1"	RGS	SW-HST5	HST5	3#10 AWG + #10 AWG GND	480V POWER	
AB-HST6-001	1"	RGS	PANEL LIFT	FUTURE SW-HST6	CONDUIT CAPPED W/ PULLSTRING FOR FUTURE	480V POWER	
AB-HSTL-001	1"	RGS	PANEL LIFT	FUTURE SW-HSTL	CONDUIT CAPPED W/ PULLSTRING FOR FUTURE	480V POWER	
AB-TRLV1-001	2 1/2"	RGS	LVP-1#14	TR-LV1	3#4/0 AWG + #4 AWG GND	480V POWER	
AB-PVP1-001	3"	RGS	TR-LV1 SECONDARY	PVP-1 MAIN BREAKER	4#250 MCM + #2 AWG GND	480V POWER	
AB-PVP1-002	3"	RGS	TR-LV1 SECONDARY	PVP-1 MAIN BREAKER	4#250 MCM + #2 AWG GND	480V POWER	
AB-PP1-001	1 1/4"	RGS	PVP-1#3	PANEL PP1	4#3 AWG + #8 AWG GND	208V POWER	
AB-SC1-001	2"	RGS	PVP-1#4	PANEL PP2	4#1 AWG + #8 AWG GND	208V POWER	
AB-ATL-001	1 1/4"	RGS	PVP-1#5	PANEL ATL	4#4 AWG + #10 AWG GND	208V POWER	
AB-PP2-001	2"	RGS	PVP-1#6	PANEL SC1	4#1 AWG + #8 AWG GND	208V POWER	
AB-LP1-001	1 1/4"	RGS	PVP-1#10	PANEL LP1	4#4 AWG + #10 AWG GND	208V POWER	
AB-EMLI-001	1"	RGS	LP1#1,3	EMERGENCY LIGHTING INVERTER EMLI	4#6 AWG + #10 AWG GND	208V POWER	
AB-VRF1-001	1 1/4"	RGS	PP2#31,33	VRF-1	4#4 AWG + #10 AWG GND	208V POWER	
AB-VRF2-001	1 1/4"	RGS	PP2#32,34	VRF-2	4#4 AWG + #10 AWG GND	208V POWER	
AB-VRF3-001	1 1/4"	RGS	PP2#35,37	VRF-3	4#4 AWG + #10 AWG GND	208V POWER	
AB-HT2-001	3/4"	PVCRGS	PP2#36,38	2ND FLOOR HEAT TRACE CONTROLLER	2#12 AWG + #12 AWG GND	208V POWER	
AB-MIMP-001	3/4"	RGS	DC BANK A#3	HMI MIMIC PANEL	2#12 AWG + #12 AWG GND		
AB-MVMP-001	3/4"	RGS	MVABP-B07 COLLECTOR SWITCH	HMI MIMIC PANEL COLLECTOR SWITCH	CAT6E	CONTROL	
AB-LVMP-002	3/4"	RGS	LVABP-A4 COLLECTOR SWITCH	HMI MIMIC PANEL COLLECTOR SWITCH	CAT6E	CONTROL	
AB-LVPMP-003	3/4"	RGS	LVABP-A4 COLLECTOR SWITCH	HMI MIMIC PANEL COLLECTOR SWITCH	CAT6E	CONTROL	
AB-MPPLC-001	3/4"	RGS	HMI MIMIC PANEL COLLECTOR SWITCH	PLC COLLECTOR SWITCH	CAT6E	CONTROL	
AB-MPFOCE-001	3/4"	RGS	PLC COLLECTOR SWITCH	FOCE COLLECTOR SWITCH	CAT6E	CONTROL	
AT-CT480-001	2 1/2"	PVCRGS	SCADA PANEL	TO END OF AERATION TANK PATH	20 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT120-001	2 1/2"	PVCRGS	SCADA PANEL	TO END OF AERATION TANK PATH	40 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-HT120-001	2 1/2"	PVCRGS	ATL#13, AT;#15, ATL#17, ATL#19, ATL#21	HEAT TRACE CONTROLERS AT TANKS	10 SETS OF (2#12 AWG + #12 AWG GND)	120V POWER	
AT-PREC-001	1 1/4"	PVCRGS	ATL#1	MAINTENACE RECEPTACLES PASS 1A/1B, 2D/2C, 3A/3B, 4A/4B, 5A/5B	2 #4 AWG + #4 AWG GND	120V POWER	
AT-PREC-002	1 1/4"	PVCRGS	ATL#2	MAINTENACE RECPETACLES PASS 1C/1D, 2B/2A, 3C/3D, 4C/4D, 5C/5D	2 #4 AWG + #4 AWG GND	120V POWER	
AT-PBOV-001	1"	PVCRGS	ATH#21,23	BLOW-OFF VALVE	4#12 AWG	480V POWER	
AT-CBOV-001	1"	PVCRGS	SCADA PANEL	BLOW-OFF VALVE	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-P1201AB-001	1"	PVCRGS	ATL#3	TANK 1 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1201AB-002	1"	PVCRGS	TANK 1 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	TANK 1 PASS A/B ANALYZER 1	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1201AB-003	1"	PVCRGS	TANK 1 PASS A/B ANALYZER 1	TANK 1 PASS A/B ANALYZER 2	2#12 AWG + #12 AWG GND	120V POWER	
AT-CT1201AB1-001	1"	PVCRGS	AT-CT120-001	TANK 1 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1201AB1-002	1"	PVCRGS	TANK 1 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	TANK 1 PASS A/B ANALYZER 1	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1201AB1-003	1"	PVCRGS	TANK 1 PASS A/B ANALYZER 1	TANK 1 PASS A/B ANALYZER 2	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1201AB2-001	1"	PVCRGS	AT-CT120-001	TANK 1 PASS A/B VENTURI FLOW TRANSMITTER	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CTRTD1AB-001	1"	PVCRGS	TANK 1 PASS A/B VENTURI FLOW TRANSMITTER	VENTURI TUBE	RTD CABLE	CONTROL	
AT-CT4801AB-001	1"	PVCRGS	SCADA PANEL	TANK 1 PASS A/B MOTORIZED VALVE	4#12 AWG	CONTROL	

SECTION 16900 - CABLE AND CONDUIT SCHEDULE - AERATION BLOWER BUILDING

CONDUIT NO.	SIZE	TYPE	FROM	TO	CABLE & SIZE	PURPOSE	REMARKS
AT-P4801AB-001	1"	PVCRGS	ATH#1,3	TANK 1 PASS A/B MOTORIZED VALVE	4#12 AWG	480V POWER	
AT-P4801AB-002	1"	PVCRGS	TANK 1 PASS A/B MOTORIZED VALVE	TANK 1 PASS A/B VALVE REMOTE HAND STATION	BELDEN 3084A T5U500	CONTROL	
AT-HT1201AD-001	3/4"	PVCRGS	ATL#13	TANK 1 HEAT TRACE CONTROLLER	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1201CD-001	1"	PVCRGS	ATL#4	TANK 1 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1201CD-002	1"	PVCRGS	TANK 1 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	TANK 1 PASS C/D ANALYZER 1	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1201CD-003	1"	PVCRGS	TANK 1 PASS C/D ANALYZER 1	TANK 1 PASS C/D ANALYZER 2	2#12 AWG + #12 AWG GND	120V POWER	
AT-CT1201CD1-001	1"	PVCRGS	AT-CT120-001	TANK 1 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1201CD1-002	1"	PVCRGS	TANK 1 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	TANK 1 PASS C/D ANALYZER 1	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1201CD1-003	1"	PVCRGS	TANK 1 PASS C/D ANALYZER 1	TANK 1 PASS C/D ANALYZER 2	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1201CD2-001	1"	PVCRGS	AT-CT120-001	TANK 1 PASS C/D VENTURI FLOW TRANSMITTER	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CTRTD1CD-001	1"	PVCRGS	TANK 1 PASS C/D VENTURI FLOW TRANSMITTER	VENTURI TUBE	RTD CABLE	CONTROL	
AT-CT4801CD-001	1"	PVCRGS	SCADA PANEL	TANK 1 PASS C/D MOTORIZED VALVE	4#12 AWG	CONTROL	
AT-P4801CD-001	1"	PVCRGS	ATH#2,4	TANK 1 PASS C/D MOTORIZED VALVE	4#12 AWG	480V POWER	
AT-P4801CD-002	1"	PVCRGS	TANK 1 PASS C/D MOTORIZED VALVE	TANK 1 PASS C/D VALVE REMOTE HAND STATION	BELDEN 3084A T5U500	CONTROL	
AT-P1202DC-001	1"	PVCRGS	ATL#5	TANK 2 PASS D/C ANALYZER ELECTRICAL ENCLOSURE	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1202DC-002	1"	PVCRGS	TANK 2 PASS D/C ANALYZER ELECTRICAL ENCLOSURE	TANK 2 PASS D/C PASS C/D ANALYZER 1	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1202DC-003	1"	PVCRGS	TANK 2 PASS D/C ANALYZER 1	TANK 2 PASS D/C ANALYZER 2	2#12 AWG + #12 AWG GND	120V POWER	
AT-CT1202DC1-001	1"	PVCRGS	AT-CT120-001	TANK 2 PASS D/C ANALYZER ELECTRICAL ENCLOSURE	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1202DC1-002	1"	PVCRGS	TANK 2 PASS D/C ANALYZER ELECTRICAL ENCLOSURE	TANK 2 PASS D/C ANALYZER 1	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1202DC1-003	1"	PVCRGS	TANK 2 PASS D/C ANALYZER 1	TANK 2 PASS D/C ANALYZER 2	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1202DC2-001	1"	PVCRGS	AT-CT120-001	TANK 2 PASS D/C VENTURI FLOW TRANSMITTER	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CTRTD2DC-001	1"	PVCRGS	TANK 2 PASS D/C VENTURI FLOW TRANSMITTER	VENTURI TUBE	RTD CABLE	CONTROL	
AT-CT4802DC-001	1"	PVCRGS	SCADA PANEL	TANK 2 PASS D/C MOTORIZED VALVE	4#12 AWG	CONTROL	
AT-P4802DC-001	1"	PVCRGS	ATH#5,7	TANK 2 PASS D/C MOTORIZED VALVE	4#12 AWG	480V POWER	
AT-P4802DC-002	1"	PVCRGS	TANK 2 PASS D/C MOTORIZED VALVE	TANK 2 PASS D/C VALVE REMOTE HAND STATION	BELDEN 3084A T5U500	CONTROL	
AT-HT1202AD-001	3/4"	PVCRGS	ATL#15	TANK 2 HEAT TRACE CONTROLLER	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1202BA-001	1"	PVCRGS	ATL#6	TANK 2 PASS B/A ANALYZER ELECTRICAL ENCLOSURE	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1202BA-002	1"	PVCRGS	TANK 2 PASS B/A ANALYZER ELECTRICAL ENCLOSURE	TANK 2 PASS B/A PASS C/D ANALYZER 1	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1202BA-003	1"	PVCRGS	TANK 2 PASS B/A ANALYZER 1	TANK 2 PASS B/A ANALYZER 2	2#12 AWG + #12 AWG GND	120V POWER	
AT-CT1202BA1-001	1"	PVCRGS	AT-CT120-001	TANK 2 PASS B/A ANALYZER ELECTRICAL ENCLOSURE	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1202BA1-002	1"	PVCRGS	TANK 2 PASS B/A ANALYZER ELECTRICAL ENCLOSURE	TANK 2 PASS B/A ANALYZER 1	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1202BA1-003	1"	PVCRGS	TANK 2 PASS B/A ANALYZER 1	TANK 2 PASS B/A ANALYZER 2	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1202BA2-001	1"	PVCRGS	AT-CT120-001	TANK 2 PASS B/A VENTURI FLOW TRANSMITTER	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CTRTD2BA-001	1"	PVCRGS	TANK 2 PASS B/A VENTURI FLOW TRANSMITTER	VENTURI TUBE	RTD CABLE	CONTROL	
AT-CT4802BA-001	1"	PVCRGS	SCADA PANEL	TANK 2 PASS B/A MOTORIZED VALVE	4#12 AWG	CONTROL	
AT-P4802BA-001	1"	PVCRGS	ATH#6,8	TANK 2 PASS B/A MOTORIZED VALVE	4#12 AWG	480V POWER	
AT-P4802BA-002	1"	PVCRGS	TANK 2 PASS B/A MOTORIZED VALVE	TANK 2 PASS B/A VALVE REMOTE HAND STATION	BELDEN 3084A T5U500	CONTROL	
AT-P1203AB-001	1"	PVCRGS	ATL#7	TANK 3 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1203AB-002	1"	PVCRGS	TANK 3 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	TANK 3 PASS A/B ANALYZER 1	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1203AB-003	1"	PVCRGS	TANK 3 PASS A/B ANALYZER 1	TANK 3 PASS A/B ANALYZER 2	2#12 AWG + #12 AWG GND	120V POWER	
AT-CT1203AB1-001	1"	PVCRGS	AT-CT120-001	TANK 3 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1203AB1-002	1"	PVCRGS	TANK 3 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	TANK 3 PASS A/B ANALYZER 1	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1203AB1-003	1"	PVCRGS	TANK 3 PASS A/B ANALYZER 1	TANK 3 PASS A/B ANALYZER 2	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1203AB2-001	1"	PVCRGS	AT-CT120-001	TANK 3 PASS A/B VENTURI FLOW TRANSMITTER	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CTRTD3AB-001	1"	PVCRGS	TANK 3 PASS A/B VENTURI FLOW TRANSMITTER	VENTURI TUBE	RTD CABLE	CONTROL	
AT-CT4803AB-001	1"	PVCRGS	SCADA PANEL	TANK 3 PASS A/B MOTORIZED VALVE	4#12 AWG	CONTROL	
AT-P4803AB-001	1"	PVCRGS	ATH#9,11	TANK 3 PASS A/B MOTORIZED VALVE	4#12 AWG	480V POWER	
AT-P4802AB-002	1"	PVCRGS	TANK 3 PASS A/B MOTORIZED VALVE	TANK 3 PASS A/B VALVE REMOTE HAND STATION	BELDEN 3084A T5U500	CONTROL	
AT-HT1202AD-001	3/4"	PVCRGS	ATL#17	TANK 3 HEAT TRACE CONTROLLER	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1203CD-001	1"	PVCRGS	ATL#8	TANK 3 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1203CD-002	1"	PVCRGS	TANK 3 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	TANK 3 PASS C/D ANALYZER 1	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1203CD-003	1"	PVCRGS	TANK 3 PASS C/D ANALYZER 1	TANK 3 PASS C/D ANALYZER 2	2#12 AWG + #12 AWG GND	120V POWER	
AT-CT1203CD1-001	1"	PVCRGS	AT-CT120-001	TANK 3 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1203CD1-002	1"	PVCRGS	TANK 3 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	TANK 3 PASS C/D ANALYZER 1	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1203CD1-003	1"	PVCRGS	TANK 3 PASS C/D ANALYZER 1	TANK 3 PASS C/D ANALYZER 2	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1203CD2-001	1"	PVCRGS	AT-CT120-001	TANK 3 PASS C/D VENTURI FLOW TRANSMITTER	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CTRTD3CD-001	1"	PVCRGS	TANK 3 PASS C/D VENTURI FLOW TRANSMITTER	VENTURI TUBE	RTD CABLE	CONTROL	
AT-CT4803CD-001	1"	PVCRGS	SCADA PANEL	TANK 3 PASS C/D MOTORIZED VALVE	4#12 AWG	CONTROL	
AT-P4803CD-001	1"	PVCRGS	ATH#10,12	TANK 3 PASS C/D MOTORIZED VALVE	4#12 AWG	480V POWER	
AT-P4803CD-002	1"	PVCRGS	TANK 3 PASS C/D MOTORIZED VALVE	TANK 3 PASS C/D VALVE REMOTE HAND STATION	BELDEN 3084A T5U500	CONTROL	
AT-P1204AB-001	1"	PVCRGS	ATL#9	TANK 4 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1204AB-002	1"	PVCRGS	TANK 4 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	TANK 4 PASS A/B ANALYZER 1	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1204AB-003	1"	PVCRGS	TANK 4 PASS A/B ANALYZER 1	TANK 4 PASS A/B ANALYZER 2	2#12 AWG + #12 AWG GND	120V POWER	
AT-CT1204AB1-001	1"	PVCRGS	AT-CT120-001	TANK 4 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1204AB1-002	1"	PVCRGS	TANK 4 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	TANK 4 PASS A/B PASS C/D ANALYZER 1	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1204AB1-003	1"	PVCRGS	TANK 4 PASS A/B ANALYZER 1	TANK 4 PASS A/B ANALYZER 2	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1204AB2-001	1"	PVCRGS	AT-CT120-001	TANK 4 PASS A/B VENTURI FLOW TRANSMITTER	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CTRTD4AB-001	1"	PVCRGS	TANK 4 PASS A/B VENTURI FLOW TRANSMITTER	VENTURI TUBE	RTD CABLE	CONTROL	
AT-CT4804AB-001	1"	PVCRGS	SCADA PANEL	TANK 4 PASS A/B MOTORIZED VALVE	4#12 AWG	CONTROL	
AT-P4804AB-001	1"	PVCRGS	ATH#13,15	TANK 4 PASS A/B MOTORIZED VALVE	4#12 AWG	480V POWER	
AT-P4804AB-002	1"	PVCRGS	TANK 4 PASS A/B MOTORIZED VALVE	TANK 4 PASS A/B VALVE REMOTE HAND STATION	BELDEN 3084A T5U500	CONTROL	
AT-HT1204AD-001	3/4"	PVCRGS	ATL#19	TANK 4 HEAT TRACE CONTROLLER	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1204CD-001	1"	PVCRGS	ATL#10	TANK 4 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1204CD-002	1"	PVCRGS	TANK 4 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	TANK 4 PASS C/D ANALYZER 1	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1204CD-003	1"	PVCRGS	TANK 4 PASS C/D ANALYZER 1	TANK 4 PASS C/D ANALYZER 2	2#12 AWG + #12 AWG GND	120V POWER	
AT-CT1204CD1-001	1"	PVCRGS	AT-CT120-001	TANK 4 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1204CD1-002	1"	PVCRGS	TANK 4 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	TANK 4 PASS C/D ANALYZER 1	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1204CD1-003	1"	PVCRGS	TANK 4 PASS C/D ANALYZER 1	TANK 4 PASS C/D ANALYZER 2	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1204CD2-001	1"	PVCRGS	AT-CT120-001	TANK 4 PASS C/D VENTURI FLOW TRANSMITTER	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CTRTD4CD-001	1"	PVCRGS	TANK 4 PASS C/D VENTURI FLOW TRANSMITTER	VENTURI TUBE	RTD CABLE	CONTROL	
AT-CT4804CD-001	1"	PVCRGS	SCADA PANEL	TANK 4 PASS C/D MOTORIZED VALVE	4#12 AWG	CONTROL	
AT-P4804CD-001	1"	PVCRGS	ATH#14,16	TANK 4 PASS C/D MOTORIZED VALVE	4#12 AWG	480V POWER	
AT-P4804CD-002	1"	PVCRGS	TANK 4 PASS C/D MOTORIZED VALVE	TANK 4 PASS C/D VALVE REMOTE HAND STATION	BELDEN 3084A T5U500	CONTROL	
AT-P1205AB-001	1"	PVCRGS	ATL#11	TANK 5 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1205AB-002	1"	PVCRGS	TANK 5 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	TANK 5 PASS A/B ANALYZER 1	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1205AB-003	1"	PVCRGS	TANK 5 PASS A/B ANALYZER 1	TANK 5 PASS A/B ANALYZER 2	2#12 AWG + #12 AWG GND	120V POWER	
AT-CT1205AB1-001	1"	PVCRGS	AT-CT120-001	TANK 5 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1205AB1-002	1"	PVCRGS	TANK 5 PASS A/B ANALYZER ELECTRICAL ENCLOSURE	TANK 5 PASS A/B ANALYZER 1	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1205AB1-003	1"	PVCRGS	TANK 5 PASS A/B ANALYZER 1	TANK 5 PASS A/B ANALYZER 2	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1205AB2-001	1"	PVCRGS	AT-CT120-001	TANK 5 PASS A/B VENTURI FLOW TRANSMITTER	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CTRTD5AB-001	1"	PVCRGS	TANK 5 PASS A/B VENTURI FLOW TRANSMITTER	VENTURI TUBE	RTD CABLE	CONTROL	
AT-CT4805AB-001	1"	PVCRGS	SCADA PANEL	TANK 5 PASS A/B MOTORIZED VALVE	4#12 AWG	CONTROL	
AT-P4805AB-001	1"	PVCRGS	ATH#17,19	TANK 5 PASS A/B MOTORIZED VALVE	4#12 AWG	480V POWER	
AT-P4805AB-002	1"	PVCRGS	TANK 5 PASS A/B MOTORIZED VALVE	TANK 5 PASS A/B VALVE REMOTE HAND STATION	BELDEN 3084A T5U500	CONTROL	
AT-HT1205AD-001	3/4"	PVCRGS	ATL#21	TANK 5 HEAT TRACE CONTROLLER	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1205CD-001	1"	PVCRGS	ATL#12	TANK 5 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1205CD-002	1"	PVCRGS	TANK 5 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	TANK 5 PASS C/D ANALYZER 1	2#12 AWG + #12 AWG GND	120V POWER	
AT-P1205CD-003	1"	PVCRGS	TANK 5 PASS C/D ANALYZER 1	TANK 5 PASS C/D ANALYZER 2	2#12 AWG + #12 AWG GND	120V POWER	

SECTION 16900 - CABLE AND CONDUIT SCHEDULE - AERATION BLOWER BUILDING

CONDUIT NO.	SIZE	TYPE	FROM	TO	CABLE & SIZE	PURPOSE	REMARKS
AT-CT1205CD1-001	1"	PVCRGS	AT-CT120-001	TANK 5 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1205CD1-002	1"	PVCRGS	TANK 5 PASS C/D ANALYZER ELECTRICAL ENCLOSURE	TANK 5 PASS C/D ANALYZER 1	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1205CD1-003	1"	PVCRGS	TANK 5 PASS C/D ANALYZER 1	TANK 5 PASS C/D ANALYZER 2	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CT1205CD2-001	1"	PVCRGS	AT-CT120-001	TANK 5 PASS C/D VENTURI FLOW TRANSMITTER	2 TWISTED SHIELDED PAIR (#14 AWG)	CONTROL	
AT-CTRTD5CD-001	1"	PVCRGS	TANK 5 PASS C/D VENTURI FLOW TRANSMITTER	VENTURI TUBE	RTD CABLE	CONTROL	
AT-CT4805CD-001	1"	PVCRGS	SCADA PANEL	TANK 5 PASS C/D MOTORIZED VALVE	4#12 AWG	CONTROL	
AT-P4805CD-001	1"	PVCRGS	FIND	TANK 5 PASS C/D MOTORIZED VALVE	4#12 AWG	480V POWER	
AT-P4805CD-002	1"	PVCRGS	TANK 5 PASS C/D MOTORIZED VALVE	TANK 5 PASS C/D VALVE REMOTE HAND STATION	BELDEN 3084A T5U500	CONTROL	

SECTION 16911

ELECTRIC MONITORING AND CONTROL SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The Contractor shall furnish, install, test and place into satisfactory operation electrical monitoring and control system as shown on the Contract Drawings and specified herein.

1. 2 RELATED SPECIFICATIONS

A. Specification 16293 – Medium Voltage Switchgear
B. Specification 16430 – Low Voltage Switchgear

1.3 REFERENCES

A. ANSI/IEEE 802.3

B. FCC Part 15, Subpart J for Class A Application - Emissions

1.4 SYSTEM DESCRIPTION

A. The system shall provide monitoring and/or control functions for the circuit breakers, motor starters, and load-break switches as shown on the Contract Drawings.

B. The system shall allow operator interface from a personal computer to obtain the monitoring and control information. Graphic displays, based upon the one line diagrams, displaying the information shall be provided.

C. The system shall consist of the following equipment, as minimum:

1. Remote devices for monitoring, control and protection, located in the equipment referenced above in 1.02.
2. Device communication interface hardware.
3. Intercommunication wiring.
4. Master control unit.
5. Software.
6. Printer.
7. Ancillary equipment.
8. Start-up.
9. Training Services.

1.5 DESIGN REQUIREMENTS

A. The Contractor shall furnish and install a complete EMCS.

B. The completed EMCS shall allow operators to access and control remote devices and circuit breakers from a central computer.

C. Software shall allow operating screens to be modified and arranged, as desired, by County personnel.

D. System information, as deemed critical by the County, shall be logged, printed, and displayed.

E. The Contractor shall furnish and install all hardware and software required to achieve, transfer, and operate all communications and signals with the EMCS system.

1.6 SUBMITTALS

A. Submit the following in accordance with General Conditions, Article GC-14 – Contractor Submissions; and as specified under Division 1 of the Specifications.

B. Working Drawings:
   1. Equipment specifications and data sheets identifying all materials used and methods of fabrication.
   2. Complete assembly, layout, and installation drawings with clearly marked dimensions.
   3. Equipment cross section drawings.
   4. Weights of all component parts, assembled weight of units and approximate total shipping weight.
   5. Interconnection Wiring Diagrams.
   6. List of Spare Parts.
   7. List of Special Tools.
   8. Installation instructions.
   9. All communications hardware, software and sensor devices shall be submitted in accordance with the requirements of the Specifications.

C. Certificates of Compliance/Manufacture.
   1. Letter stating qualifications of manufacturer as described in 1.7.

D. Reports
   1. All shop test and field test reports.
   2. All manufacturer's site visit reports.

E. Operation and maintenance manuals shall be submitted in accordance with Specification 01730, Operations and Maintenance Data.

1.7 QUALITY ASSURANCE AND QUALIFICATIONS

A. All components of the equipment shall be provided by one vendor who shall have the sole responsibility of matching all components and providing equipment which functions together as a system.

B. The manufacturer of the equipment shall have been regularly engaged in the manufacture of the specified remote devices for a period of at least five (5) years and demonstrate that these products have been utilized in satisfactory use in functioning systems for similar applications. The manufacturer shall have at least five (5) years demonstrated capability in EMCS design, installation and start-up.

C. The manufacturer shall submit a list of at least 100 existing operating installations each having a minimum of 300 remote devices communicating with a remote personal computer.

1.8 SPARE PARTS, TOOLS AND SUPPLIES

A. The Contractor shall furnish all spare parts in conformance with Division 1. Deliver all spare parts, tools and supplies with the equipment, neatly wrapped or boxed, indexed and tagged with complete information for use and reordering.

B. Furnish the following spare parts as minimum:
   1. One (1) complete set of personal computer modules.

C. Furnish the following tools.
   1. All tools necessary to service, disassemble, repair, and adjust the equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers and their particular products shall be as follows:
   1. ABB
   2. Eaton
   3. Square D

B. The following specifications refer to various Eaton products and are meant as a general guide to the system performance required. Different manufacturers use

alternate methods and equipment to perform the functions required. It is the intent of these specifications that all required equipment, such as power supplies, communication and metering modules, relays, etc. be furnished and installed to form a complete system, whether specified or not.

C. The personnel computers specified shall meet as minimum, the function and hardware listed.

2.2 GENERAL DESCRIPTION

A. The Electrical Monitoring and Control System (EMCS) is defined to include, but not to be limited to, remote devices for monitoring, control, and protection, device communication interface hardware, intercommunication wiring, master control unit system, software, printer and ancillary equipment.

B. The EMCS shall comply with the applicable portions of ANSI/IEEE 802.3 and NEMA standards. In addition, the master control unit shall comply with FCC Emission Standards specified in Part 15, Subpart J for Class A application.

2.3 EMCS OPERATION

A. The EMCS shall be capable of operating on a master control unit consisting of a personal computer, or approved equal having the following features:
   1. Minimum 3.3 GHZ I Core 5 processor with 64GB SD RAM, 4 TB hard disk drive, 2nd generation DVD-ROM drive with decoder board, Ethernet network card, 32 bit soundcard, stereo speakers, 24 inch color LCD monitor, graphics card with 16 GB RAM, full-sized keyboard, mouse and laser printer.
   2. Latest version of MICROSOFT WINDOWS NT operating system at time of bid.
   3. Parallel and serial ports.
   4. Auto-reboot capability upon return from power failure.
   5. 100% IBM compatible.

B. A second personal computer shall be furnished and installed with all the equipment and operating parameters as described in A. above. It shall be configured with the first computer such that all information in the first computer will simultaneously be in the second computer. This "hot stand-by" configuration shall enable all system data entering the first computer to also enter the second computer simultaneously. In the event of a failure of the first computer, the second computer will automatically take over, without any interruption. Any requirements specified henceforth for the master control unit or personal computer, shall apply to the second, stand-by computer also.

C. The system shall be capable of communicating with up to a minimum of 300 devices and shall be interconnected with #18 gauge twisted pair shielded cable, Belden 9463 family, in 3/4 inch conduit for the communication channel. The communication lines shall consist of a maximum of five branches, each capable of being extended up to 8,500 feet from the master control unit without repeaters. The speed of data communication on the network shall be a minimum of 19600 baud.

D. The system shall provide automatic system alarms based on detected faults in the master control unit, individual remote devices, or communications network.

E. The system shall have the capability of being programmed and modified on-line. It shall not be necessary to shut down any part of the system during programming operations.

F. The EMCS communication wires shall be capable of being run in cable trays or conduit containing power conductors without affecting data integrity. If system design is such that data communications would be affected by E.M.F. interference coming from power conductors, the manufacturer shall furnish fiber-optic data line.

G. The EMCS shall be capable of monitoring and storing trending energy consumption data associated with this building, for submission to PSEG in accordance with applicable rebate program requirements. The exact data points to be collected, as well as the format in which the data must be stored, shall be coordinated with PSEG.

2.4 COMPONENT INTERFACE

A. A Computer Operated Network Interface (CONI) card shall be installed within the personal computer to provide interface to the remote devices. The interface card shall contain a transmitter/receiver chip which shall provide positive two-way communication between the master control unit and the individual remote devices. This interface card shall contain a real-time clock for resolution and reporting/recording of data.

B. Where shown on the Contract Drawings or specified herein to interface with other systems, furnish and install a Master Incom Network Translator (MINT) capable of translating the coded binary messages of the remote devices located on the local area twisted pair network to 10-byte ASCII encoded hexadecimal output/input suitable for an RS232c port. Communication from this port shall be suitable for any personal computer or Programmable Logic Controller. The MINT shall be supplied by suitable 120-volt power.

C. Remote devices shall either have built-in communication capability or separately mounted communication module capable of communicating information between the remote device and the master control unit. Each remote device with built-in communication capability or each separately mounted communication module (PONI card) shall have field settable address dials or dip-switches capable of providing each remote device on the network with an individual address for identification of each remote device on the network.

D. Provide an Alarm Interface Module (AIM) to detect faults in the master control unit, individual remote devices or communication network. The AIM shall cause the operation of a Form C contact (NO/NC) capable of providing a contact signal to other systems, auto-dialers, alarm horns, etc.

E. The EMCS design shall be capable of providing remote Form C contact alarm indication at up to 100 locations anywhere on the network for the following occurrences:
   1. Personal computer failure.
   2. Alarm and/or trip signal from any other device(s) on the system.

F. Provide Form C alarm contacts as shown on the Contract Drawings.

G. The EMCS communication signal shall be Frequency Shift Keyed (FSK), carrier-based, 115 KHz nominal frequency to ensure no interference from 60-cycle power system.

H. All communication system components shall have a dielectric isolation of a minimum of 2200 volts line-to-ground without damage to communication capability.

I. The Master Personal Computer shall have the capability of supporting an unlimited number of remote computers having displays providing complete real-time and historical information, on-line real-time system monitoring, and password protected control. Provide a separate computer interface wiring system as recommended by the manufacturer for the number of remote computers shown on the Contract Drawings.

J. The EMCS shall be capable of interfacing with any existing and/or new customer supplied broad band network in the following manner:
   1. Various sections of the EMCS shall be capable of being connected individually at up to 18 locations on the broad band network.
   2. The EMCS shall only require one channel of the broad band network regardless of number of connection points.

3. Each section of the EMCS shall be capable of being connected to the broad band network by any one of the following:
    a. RS232c interface.
    b. ETHERNET interface.
    c. ARCNET interface.
    d. RS485

K. Provide an Ethernet interface where shown on the Contract Drawings. Provide equipment for transmitting data over fiber optic cables.

L. The EMCS shall be capable of being monitored and controlled by a personal computer from a remote location by means of dial-up phone modem. The remote and local computer shall have simultaneous yet independent real time password-protected monitoring and/or control capability.

2.5 EMCS SOFTWARE

A. The software system shall have on-line, full-screen editing to facilitate the programming and monitoring of the system. The software shall be MICROSOFT WINDOWS-based and be capable of providing separate screens at the Master Control Unit to monitor vital system parameters of up to a minimum of 300 remote devices. The screens shall show all parameters which are available from the individual remote devices by device, including but not limited to all metered values, load status, alarm status, energy data, device position and/or status. In addition, the screens shall be capable of providing for suitable tripping, closing, and opening of appropriate remote devices.

B. The computer and software shall be capable of running other MICROSOFT WINDOWS-compatible packaged software programs, such as word processing, while constantly monitoring electrical equipment on the network. An alarm shall be shown graphically on the screen and an audible alarm shall be available for signaling problems while the computer is utilized for other programs. Software shall be user-friendly with menu-driven screens with the following features:
    1. Include the following minimum device summary screens showing up to 18 maximum devices per screen:
        a. Current and status.
        b. Energy and status.
        c. Alarms.
    2. It shall be possible to view all parameters of any device shown on the summary current or energy screens with a maximum of two operator computer strokes.
    3. The status information on both of the summary screens and the individual device screens shall include the following information:
        a. Device “ON”, “OFF”, “TRIPPED”, and “COMMUNICATION” status.

b. High load device alarms.
c. Overcurrent pickup alarm.
d. Reason for trip.
e. Current magnitude of trip.

4. The EMCS software shall provide:
   a. System/device alarm logging and reporting: Any changes in any device, or the system itself including log on/off, attempted log on/off, power on/off at system master computer, shall be identified and alarmed.
   b. Time/event logging: The time and causes of each event shall be logged directly to the master control unit file and/or a printer. Time stamping capability in seconds shall be provided at the system master computer of device on/off, device alarm, device trip, and device no response.
   c. Data Trending: The software shall include the following trending features:
      1) All information monitored by every remote device shall be capable of being communicated and automatically trended.
      2) Trending time interval and amount of information to be trended shall be user-selectable for each device. Time interval selection shall be user-selectable to discrete time blocks from 10 minutes to monthly.
   d. Information storage and retrieval by event: Data shall be capable of being time sorted for use in reports that analyze patterns of device and system alarms, peak demand and kWH usage, and overall system usage. Reports shall be capable of being generated from standard formats or customized by the operator. Report generation shall include the capability to present color diagrams and charts to facilitate interpretation of historical trend data.

C. PASSWORD PROTECTION: The following password security protection features shall be provided:
   1. The EMCS software shall be capable of having a minimum of 30 separate user-defined passwords.
   2. Password shall have a minimum of five (5) alphanumeric characters.
   3. All actions, i.e., log on/off, device control, alarm acknowledgment, etc. shall be time and date stamped in the event log.
   4. Password security access shall be determined individually by device for the following functions:
      a. Alarm acknowledgment.
      b. Device control.
      c. Event logging.
      d. Analog alarming.
      e. Trending.
   5. Password security for the following system functions shall be provided:
      a. Password creation and security level.
      b. File management.

6. The EMCS software password security shall be capable of being utilized for both local and remote computers. Individual operator passwords shall be required at every computer location. Each operator's capability to interface with the system shall be keyed to his/her entered password and his/her associated security level.

D. Diagnostics shall be provided to provide information on device or system malfunction, such as devices not communicating, printer failures, etc.

E. The software shall allow for communication of system information to a second computer system. This shall be accomplished via a two-way RS232 signal which is channeled from the serial port of the primary computer to the secondary computer or PLC.

F. Customized software to utilize the data at the secondary computer or PLC shall be provided by the secondary computer or PLC manufacturer or user. The software shall provide the capability for remote-site monitoring through the use of a modem and standard phone lines or leased telephone lines. The EMCS software/hardware shall be capable as a minimum of interfacing with JOHNSON CONTROLS MEGA SYS, HONEYWELL DELTA NET GRAPHICS CENTRAL, and LANDIS-GYR building systems.

G. The software shall allow the user to set up to 200 individual computer alarm levels for all monitored parameters, such as setting low and high alarm levels for voltage, current, motor run time, etc. These alarm levels shall be independent of device built-in alarm levels.

2.6 DRAWING GRAPHICS CAPABILITY

A. The software shall include the capability to create custom object oriented programmed (OOP) graphics to allow for such things as system one-line drawings, flow diagram of system, equipment front view drawing or any graphic representation desired by the County. The drawings shall allow for the insertion of customer-selected variable tags providing real-time available information from the remote devices. The graphics package shall allow for unlimited screen penetration to lower-level detailed screens. Graphics packages shall be approved by the Engineer and have as a minimum the following specified features.
   1. Animation (changing of shape, color, orientation, or configuration) of any object or line on the screen based on a change of incoming monitored data and/or a software-performed calculation shall be provided. For example, changing of the single-line bus color based on open, closed, tripped status, or monitored values of a circuit breaker or starter.
   2. Ability to perform mathematical operations and logic functions on the incoming monitored data.
   3. Display in a real-time trending mode a graphical representation of either monitored or calculated data. This shall include line charts, or bar graphs with animation.

4. Library of objects for customer modification of graphic screens.
5. The Contractor shall provide custom-developed screens to match customer one-line drawings, customer floor plans and actual power distribution equipment front elevations as part of the graphics package. The County shall be able to select colors, numbering scheme, and general arrangement of screens. Provide a master overview screen listing all subscreens by contract designation and from which any subscreen can be selected by mouse-click operation.
6. Automatic routing to appropriate one-line shall be provided on an alarm condition.
7. The EMCS software shall support Dynamic Data Exchange (DDE) allowing the sharing of data with any other DDE-compatible software.

2.7 SYSTEM COMPONENTS

A. Furnish and install a personal computer meeting the requirements previously outlined. Provide as a minimum, EMCS software package and the latest MICROSOFT OFFICE program. Master unit and software shall be tested as a complete assembly before shipment.

B. Furnish and install Hewlett Packard Laser Printer 6L capable of color printing of custom charts, graphs, or plots.

C. The EMCS shall be capable of communicating with the following devices where shown on the Contract Drawings or specified to be included in assembled equipment:
   1. Meter Monitor (MM) device, Eaton type Westinghouse IQ Data or approved equal.
   2. Generator Meter Monitor (GMM), Eaton type Westinghouse IQ Generator or approved equal.
   3. Meter Monitor and Protection (MM&P) device, Eaton type Westinghouse IQ DP-4000, or approved equal.
   4. Meter Analyzer and Protection (MA&P) device, Eaton type IQ Analyzer or approved equal.
   5. Sub Metering Module (SMM), Eaton type Westinghouse Energy Sentinel or approved equal.
   6. Central Energy Display (CED), Eaton type Westinghouse Central Energy Display or approved equal.
   7. Addressable Relay (ADR), Eaton type Westinghouse Addressable Relay-II or approved equal.
   8. Microprocessor-based Trip Unit (TU), Eaton type Westinghouse Digitrip RMS or approved equal.
   9. Assemblies Electronic Monitoring (AEM) unit to monitor microprocessor-based Trip Units, Eaton type Westinghouse Assemblies Electronic Monitor-II or approved equal.
   10. Microprocessor-based Medium Voltage Trip Unit (MVTU), Eaton type Westinghouse Digitrip 3000 or approved equal.
   11. Microprocessor Breaker Controller (BC) for opening and closing electrically operated breakers and providing status feed-back, Eaton type Westinghouse Breaker Controller.

12. Microprocessor-controlled motor starter or contactor, Eaton Advantage Motor Starter or contactor and associated Central Monitoring Unit (CMU) or approved equal.
13. Modular Overload Relay (MOR), Eaton IQ-500 or approved equal.
14. Motor Protective Relay (MPR), Eaton MP-3000 II or approved equal.
15. Microprocessor-based Automatic Transfer Switch (ATS), Eaton IQ Transfer or approved equal.
16. Resistance Temperature Detector (RTD) for transformer or motor temperature detection, Eaton Universal RTD Module or approved equal.
17. Adjustable Frequency Drives (AFD) for speed control of motors, applicable Eaton AF series drives or approved equal.
18. Microprocessor-based Analog Input Module, capable of supporting up to 16 analog input points, anywhere on the network. The analog points shall include instantaneous, average and maximum value for each point. In addition, any point on the module could be configured as a counter, digital input or elapsed time meter.

D. The ECMS software shall be capable of displaying the following information from the power distribution equipment where the devices listed in Paragraph 2.7.C above are shown on the Contract Drawings or detailed as requirements in the individual assembled equipment specifications.
   1. Medium-Voltage Switchgear (Main, Tie, and Feeder Breakers)
      a. Individual phase and ground currents.
      b. Phase-to-phase and phase-to-neutral voltages.
      c. Vars, power factor, frequency.
      d. Watts, watt demand, watt-hours.
      e. Amp demand.
      f. Alarm on circuit breaker tripping, cause of trip, and magnitude of the current causing the trip.
      g. Alarm on circuit breaker tripping, cause of trip, and magnitude of the current causing the trip.
      h. Circuit breaker status including open, close, timing to trip, and tripped.
      i. Time-stamped trip buffer including cause of trip, magnitude of trip, and time/date stamp.
      j. Circuit breaker status including open, close, timing to trip or tripped, and circuit breaker position including connected, test, or disconnected.
      k. All trip unit set points and the ability to change the set points over the communication system.
   2. Low-Voltage Switchgear/Switchboard (Incoming Line/Main Breakers)
      a. Individual phase and ground currents.
      b. Phase-to-phase and phase-to-neutral voltages.
      c. Vars, VA, power factor, frequency.
      d. Watts, watt demand, watt-hours.
      e. Alarm on circuit breaker timing out to trip (trip unit pickup)
      f. Alarm on circuit breaker tripping, cause of trip and magnitude of the current causing the trip.
      g. Circuit breaker status including open, close, timing to trip, and tripped.

h. Time-stamped trip buffer including cause of trip, magnitude of trip and time/date stamp.
i. All trip unit set points.

3. Low-Voltage Switchgear (Feeder Breakers and Tie Breakers 600A frame and above)
   a. Individual phase and ground currents.
   b. Vars, volt-amps.
   c. Watts, watt demand, watt-hours.
   d. Power factor.
   e. Alarm on circuit breaker timing out to trip (trip unit pickup).
   f. Alarm on circuit breaker tripping, cause of trip and magnitude of the current causing the trip.
   g. Circuit breaker status including open, close, timing to trip, and tripped.
   h. Time-stamped trip buffer including cause of trip, magnitude of trip and time/date stamp.

i. All trip unit set points.

4. Low-Voltage Switchboard/Panelboard/MCC (Fixed-mounted Feeder Breakers)
   a. Watts, watt demand, watt-hours
5. Medium-Voltage Motor Starters
   a. Individual phase and ground currents.
   b. Phase-to-phase and phase-to-neutral voltages.
   c. Vars, VA, power factor, frequency.
   d. Watts, watt demand, watt-hours.
   e. Total harmonic distortion.
   f. Cumulative run time in hours.
   g. Total number of starts, number of starts remaining per hour and time left since oldest start (in minutes).
   h. Motor bearing and motor winding temperatures.
   i. Alarm on motor trip unit timing out to trip (trip unit pickup), cause of alarm and magnitude of current causing the trip.
   j. Alarm on motor starter tripping, cause of trip and magnitude of the current causing the rip.
   k. Motor starter status including open, close, timing to trip, and tripped.
   l. Time-stamped trip buffer including cause of trip, magnitude of trip and time/date stamp.
   m. All trip unit set points.
6. Low-Voltage Motor Control Center (Incoming Metering)
   a. Individual phase and ground currents.
   b. Phase-to-phase and phase-to-neutral voltages.
   c. Vars, VA, power factor, frequency.
   d. Watts, watt demand, watt-hours.
7. Low-Voltage Motor Starters
   a. Individual phase and ground currents.
   b. Cumulative run time in hours.
   c. Percent phase unbalance.
   d. Alarm on motor trip unit timing out to trip (trip unit pickup), cause of alarm and magnitude of current causing the trip.
   e. Alarm on motor starter tripping, cause of trip and magnitude of the current causing the trip.
   f. Motor status including open, close, timing to trip, and tripped.
   g. Time-stamped trip buffer including cause of trip, magnitude of trip and time/date stamp.
   h. All motor starter set points.

2.8 SHOP TESTS

A. Test equipment to demonstrate that it has been properly assembled, is not overheating, is not overloading, and has no electrical or mechanical defects.

B. Perform all certified shop tests and submit the shop test reports.

C. The following standard factory tests shall be performed on the equipment provided under this section.
   1. Configure and load all software.
   2. Test and operate computer and software in a simulated system mode for minimum of 24 hours.
   3. Demonstrate full system functionality.

D. Witnessed Shop Tests:
   1. The Contractor shall perform witnessed shop tests in accordance with Section 01431 - Quality Assurance Inspection.
   2. Obtain approval of the testing procedure and test stand layout prior to scheduling a witness shop test.
   3. Test all disconnecting devices, starters and controls. Simulate controls for each circuit breaker, starter and verify all contacts, relays, etc. operate properly. Verify all meters, monitors and communication devices operate properly. Verify all miscellaneous devices, such as power supplies, transfer devices, etc., operate properly.
   4. The Contractor shall submit and obtain acceptance by the Engineer of the witness shop test prior to shipment of the equipment.

PART 3- EXECUTION

3.1 FIELD TESTS

A. After installation of the equipment, controls and all appurtenances, field test the equipment for system operation and conformance to the specified performance parameters. The Contractor shall perform field tests in accordance with Article 12 of the General Conditions and Division 1 - General Requirements. Test the equipment to demonstrate the following:
   1. Equipment has not been damaged in transportation and installation.
   2. Equipment has been properly installed.
   3. Equipment has been properly connected.
   4. Equipment is not overheating.
   5. Equipment is not overloading any part.
   6. The equipment has no electrical or mechanical defects.
   7. Compliance with performance and design parameters.
   8. System operability under all control schemes.

3.2 MANUFACTURER'S FIELD SERVICES

A. The Contractor shall furnish the services of a qualified manufacturer's service representative to assist in the installation of equipment, check the installation before it is placed into operation, assist in the performance of field tests, observe and assist initial operations and train the plant operations and maintenance staff in the care, operation and maintenance of the equipment.

B. The Contractor shall provide equipment start-up services and training in accordance with Section 01821 and as described in this section.

C. The Contractor shall provide the services of the representative for the following minimum durations:

1.	Equipment Installation and Inspection	1 visit of 5 days each
2.	Field Tests	3 visits of 5 days each
3.	Initial Operation	3 visits of 5 days each
4.	Training	2 visits of 5 days each

D. Reports: The Contractor shall submit a report from the manufacturer of each visit to the site. The Contractor shall provide complete information on time, schedule, tasks performed, persons contacted, problems corrected, test results, training, instruction, and all other pertinent information.

E. All service representatives shall sign in with the Engineer on each day they are at the construction site.

+ + END OF SECTION + +

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