

PROPOSAL

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

TO BE COMPLETED BY CONTRACTORS SUBMITTING A BID ON S3C067-08G						
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, exclusive of work covered under Bid Item Nos. 2, 3, 4, 5a, 5b, 6, 7, 8, 9, 10, and 11. <hr/>	N/A	N/A		
2.	1,200 LINEAR FEET	For concrete crack repair (Section 03930) <hr/>				
3.	4,400 SQUARE FEET	For concrete spall repair (Section 03930) <hr/>				
4.	24 EACH	For rehabilitation of 8" Drain in Final Sedimentation Tanks <hr/>				

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ITEM NO.	APPROX. QUANTITIES	ITEMS BID WITH AMOUNT BID WRITTEN IN WORDS				
5a.	96 EACH	For replacement of Flap Valve in North Final Sedimentation Tanks _____				
5b.	96 EACH	For replacement of Flap Valve in South Final Sedimentation Tanks _____				
6	1,100 EACH	For re-anchoring existing Density Current Baffle, Baffle Plate or Weir in Final Sedimentation Tanks _____				
7	Lump Sum	For furnishing all Labor, Materials and Equipment required for all Construction work associated with North and South RAS Pump Stations _____				

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ITEM NO.	APPROX. QUANTITIES	ITEMS BID WITH AMOUNT BID WRITTEN IN WORDS				
8	Lump Sum	Add Alternate #1 for furnishing all Labor, Materials and Equipment required for all Construction work associated with East Pipe Gallery Low Pressure Air Pass Flow Meter and Valve replacement. <hr/>				
9	Lump Sum	Add Alternate #2 for furnishing all Labor, Materials and Equipment required for all Construction work associated with East Pipe Gallery Low Pressure Air Grid Flow Meter and Valve replacement. <hr/>				
10	Allowance	For furnishing all labor, materials, equipment, and incidentals for unforeseen conditions and associated additional work. <u>Five Hundred Thousand</u> <u>No</u>	N/A	N/A	\$500,000	00
11	Allowance	For furnishing all labor, materials, equipment, and incidentals for Cedar Creek Construction Office Improvements. Necessary repairs and improvements include, but not limited to, new roofing, siding, HVAC system, and demolition of the construction trailers surrounding the construction house. Details to be issued as a Supplemental Bulletin during the construction period. <u>Five Hundred Thousand</u> <u>No</u>	N/A	N/A	\$500,000	00

PROPOSAL

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<b>TOTAL BASE BID (Sum of Bid Item No. 1 through Bid Item No. 7 Plus Bid Item No. 10 &amp; 11): MUST BE WRITTEN IN FIGURES:</b>
\$
<b>TOTAL BASE BID (Sum of Bid Item No. 1 through Bid Item No. 7 Plus Bid Item No. 10 &amp; 11): MUST BE WRITTEN IN WORDS:</b>

<b>TOTAL BASE BID Plus ADD ALTERNATE #1 (Sum of Bid Item No. 1 through Bid Item No. 8 Plus Bid Item No. 10 &amp; 11): MUST BE WRITTEN IN FIGURES:</b>
<b>TOTAL BASE BID Plus ADD ALTERNATE #1 (Sum of Bid Item No. 1 through Bid Item No. 8 Plus Bid Item No. 10 &amp; 11): MUST BE WRITTEN IN WORDS:</b>

<b>TOTAL BASE BID Plus ADD ALTERNATES #1 and #2 (Sum of Bid Item No. 1 through Bid Item No. 11): MUST BE WRITTEN IN FIGURES:</b>
\$
<b>TOTAL BASE BID Plus ADD ALTERNATES #1 and #2 (Sum of Bid Item No. 1 through Bid Item No. 11): MUST BE WRITTEN IN WORDS:</b>



## PROPOSAL

### 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. 10: An allowance of five hundred thousand dollars (\$500,000.00) for unforeseen conditions, as specified in Section 01210 – Allowances.
- Item No. 11: An allowance of five hundred thousand dollars (\$500,000.00) for Cedar Creek Construction Office Improvements, as specified in section 01210 – Allowances.

All in accordance with the requirements of Division 1, Special Conditions; Section 01010, Summary of Work; Section 01210, 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
11316	Sewage Pumps	
11335	Sedimentation Tank Equipment	
13420	Magnetic Type Flow Meters	
13420	Venturi Flow Meters	
15100	Butterfly Valves	
15100	Gate Valves	
15100	Plug Valves	
15100	Check Valves	
15100	Valve Actuators – Hydraulic Cylinder Operator	

## PROPOSAL

15101	Valve Actuators – Powered	
16260	Variable Frequency Drives	

# **CONTRACT AND SPECIFICATIONS**

NASSAU COUNTY, NEW YORK  
DEPARTMENT OF PUBLIC WORKS

## **CEDAR CREEK WATER POLLUTION CONTROL PLANT SECONDARY TREATMENT IMPROVEMENTS NCDPW Contract No. S3C067-08G**



### **COUNTY EXECUTIVE**

Bruce Blakeman

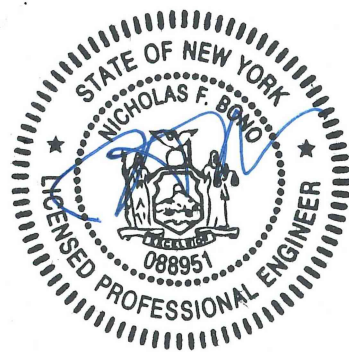
### **COMMISSIONER OF PUBLIC WORKS**

Kenneth G. Arnold, P.E.

NOVEMBER 2023

VOLUME 2 OF 2

H2M architects + engineers



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DEPARTMENT OF PUBLIC WORKS**

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PROPOSAL, AGREEMENT AND SPECIFICATIONS**

FOR

**CEDAR CREEK WATER POLLUTION CONTROL PLANT  
SECONDARY TREATMENT IMPROVEMENTS**

CAPITAL PROJECT NO. 3C067  
CONTRACT S3C067-08G

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**LIMITED HAZARDOUS MATERIALS SURVEY**

(FOR INFORMATION ONLY – NOT PART OF CONTRACT S3C067-08G CONTRACT DOCUMENTS)

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PART 1 – GENERAL

1.01 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 Cedar Creek Water Pollution Control Plant Secondary Treatment Improvements Contract No. S3C067-08G located at the Cedar Creek Water Pollution Control Plant, Nassau County, New York.
- B. The broad scope of this project is to rehabilitate the Final Sedimentation Tanks including replacing the clarifier equipment, installing sludge blanket sensors and integrate into the Plant's SCADA system. Replace the flow meter and electrically actuated butterfly valve for each Final Sedimentation Tank influent piping located in the distribution chambers. Replace the Return Activated Sludge (RAS) pumps and associated valves and flow meters. Replace the Return RAS flow meters located at passes "A" and "C" of each aeration tank. Replace the level sensors in North RAS Pump Station Wet Well. Replace the Waste Activated Sludge (WAS) flow meters located on the discharge of each WAS pump and replace the pump seal water/flow pressure sensors and pump motor temperature sensors for each WAS pump. Replace the Low Pressure Air manually operated valves and flow meters located at each pass of each aeration tank.
- 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. De-watering and cleaning of each Final Sedimentation Tank (FST).
    - b. Removal and disposal of the existing clarifier equipment.
    - c. Concrete repairs to the FSTs as required.
    - d. Furnish and install new clarifier equipment and sludge blanket sensors.
    - e. Removal and disposal of existing flow meter and electrically actuated butterfly valve on influent piping to each Final Sedimentation Tank.
    - f. Furnish and install new flow meter and electrically actuated butterfly valve on influent piping to each Final Sedimentation Tank.
    - g. Removal and disposal of existing Return Activated Sludge (RAS) pumps, valves, flow meters.
    - h. Furnish and install new RAS pumps, valves, flow meters.
    - i. Removal and disposal of existing level sensors in RAS Pump Station Wet Wells.
    - j. Furnish and install new level sensors in RAS Pump Station Wet Wells.
    - k. Removal and disposal of existing Waste Activated Sludge (WAS) flow meters, pump seal water flow/pressure and pump motor temperature sensors.
    - l. Furnish and install new WAS flow meters, pump seal water flow/pressure and pump motor temperature sensors.
    - m. Removal and disposal of existing Low Pressure Air valves and flow meters.
    - n. Furnish and install new Low Pressure Air valves, actuators and flow meters.
    - o. Electrical and control work as required for the complete installation of the above mentioned equipment.
    - p. Structural work as required for the complete installation of the above mentioned equipment and as shown on the contract documents.
    - q. Site restoration.
  - 2. The foregoing stated in Paragraph 1.01.B 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.

## 01010 – SUMMARY OF WORK

- 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.

### 1.02 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.

### 1.03 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.

### 1.04 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.

### 1.05 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.

## 01010 – SUMMARY OF WORK

- 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.

### 1.06 WORK BY OTHERS

- A. County will perform the following work:
  1. Operate all Final Sedimentation Tank (FST), Return Activated Sludge (RAS), Waste Activated Sludge (WAS), Low Pressure Air (LPA) and all other pertinent existing plant valves and plant functions as deemed necessary.
  2. Initial draining of process water from Final Sedimentation Tanks.

### 1.07 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 01010

## 01020 – ALLOWANCES

### PART 1 – GENERAL

#### 1.01 DESCRIPTION

- A. The allowances described below are to provide specific services, materials or work related to the Cedar Creek Water Pollution Control Plant Secondary Treatment Improvements – Contract No. S3C067-08G.
- 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.

#### 1.02 SCHEDULE OF ALLOWANCES

- A. General Construction Contract:
  - 1. Item 10: An allowance in the amount indicated in the Proposal for furnishing all labor, materials, equipment and incidentals for unforeseen conditions and associated additional work.

#### 1.03 BASIS FOR PAYMENT

- A. Item No. 10: 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 01020

01020 – ALLOWANCES

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PART 1 - GENERAL

1.01 - GENERAL

- A. This Section specifies the requirements for measurements and records made for payment purposes and describes the item(s) under which payment(s) will be made for the Work performed under this Contract.
- B. All work shown or specified in the Contract Documents shall be performed.
- C. Items not specified to be measured or paid for (for which no specific pay item exists in the Price Schedule) shall be included in an appropriate unit price item or in a lump-sum item.

1.02 - MEASUREMENT REQUIREMENTS

- A. All required measurements will be made by the Contractor with the Engineer and or Owner's construction representative.
- B. Any measurements not witnessed by Engineer and/or Owner's construction representative and which cannot be verified or substantiated by Engineer and/or Owner's construction representative will not be approved and payment under the item(s) requiring such measurements will not be made.
- C. Coordinate measurements monthly, for the preparation of periodic pay estimates.
- D. Where payments will be made for removing existing materials, or materials generated by work, Contractor shall be required to notify Engineer and/or Owner's construction representative so that he/she may witness the measurements.
  - 1. All materials removed without conforming to the above procedures, which Engineer and/or Owner's construction representative cannot verify or substantiate, will not be paid for.
  - 2. Maintain complete, neat, clean, and legible field notes for all measured items.
  - 3. Notes will contain spaces for Contractor's and Engineer's and/or Owner's construction representative's signatures plus additional space for comments.
  - 4. An original and a carbon copy will be made for all notes and one copy will be turned over to Engineer and/or Owner's construction representative daily.
  - 5. The Engineer's and/or Owner's construction representative's signature will not be constituted as an acceptance of the work, or the measurements made, but will mean that he was present when the measurements were made.

1.03 - SUBMITTALS

- A. See Section 01300.
- B. Field notes of all measurements for payment purposes delivered to Engineer and/or Owner's construction representative daily.
- C. Monthly Applications for Payment.

## 01021 – UNIT PRICES

- D. Record Drawings showing the locations and quantities of all items measured for payment purposes.

### 1.04 - SCHEDULING

- A. Notify Engineer and/or Owner's construction representative, as far in advance as possible, of the recording of measurements so that Engineer and/or Owner's construction representative may observe existing conditions, work being performed, and measurements being made.
- B. Allow for and afford Engineer and/or Owner's construction representative ample time, space, and equipment to observe measurements and to verify measurements and elevations.

## PART 2 - PRODUCTS

### 2.01 - GENERAL

- A. Provide all labor, materials, facilities, levels, measuring devices and all other equipment and items necessary to perform all measurements properly and accurately for payment purposes.
- B. Payment for certain items not specifically listed in the bid forms but otherwise required by the technical specifications will be deemed included as part of the General Conditions and the individual unit price and lump sum bid items provided for in the proposal.

## PART 3 - EXECUTION

- A. Perform all measuring required under this Section.
- B. Record all measurements and calculated quantities on the Record Drawings.
- C. No measurement will be made for work performed within the limits of Lump Sum Items.

<u>ITEM NO.</u>	<u>ITEM DESCRIPTION AND MEASUREMENTS</u>
2	<b><u>Concrete Crack Repair</u></b> - Measure the actual linear length of concrete cracks that are repaired as directed by Engineer in the field. Measurement will be made along the entire length of continuous cracks to be repaired.
3	<b><u>Concrete Spall Repair</u></b> - Measure the actual square footage of concrete spalls that are repaired as directed by Engineer in the field. Measurement will be made along the entire area of each surface spall that is repaired.
4	<b><u>Rehabilitation of 8" Drain in Final Sedimentation Tanks</u></b> – Quantify the actual drains that are rehabilitated as directed by Engineer in the field.
5a	<b><u>Replacement of Flap Valve in North Final Sedimentation Tanks</u></b> – Quantify the actual flap valves that are replaced as directed by Engineer in the field.
5b	<b><u>Replacement of Flap Valve in South Final Sedimentation Tanks</u></b> – Quantify the actual flap valves that are replaced as directed by Engineer in the field.

6

**Re-anchoring existing Density Current Baffle, Baffle Plate and/or Weir in Final Sedimentation Tanks** – Quantify the actual re-anchoring that is completed as directed by Engineer in the field.

#### PART 4 - PAYMENTS

##### 4.01 - GENERAL REQUIREMENTS AND STIPULATIONS

- A. No separate payments will be made for the Work under this Contract except for the pay items stipulated in this Part 4.
- B. All costs in connection with the Work will be included in one or more of the pay items, as appropriated.
- C. Each pay item will be full compensation for all costs in connection with the item including, but not limited to:
  - 1. the furnishing of all materials, labor, equipment, tools, and all incidentals,
  - 2. the installation of all materials, equipment, facilities, accessories, and appurtenant items,
  - 3. proper share of overhead and profit,
  - 4. mobilization/demobilization,
  - 5. submittals,
  - 6. General and Supplemental Conditions,
  - 7. all temporary facilities and controls
  - 8. restoration of surfaces not scheduled to be paid for by bid items
  - 9. all related and incidental work and items necessary or required to complete the Work and to provide completely connected, operational and approved systems capable of performing as required.
- D. In addition to those items described above, Paragraph 4.02 lists specific items of work under each pay item to assist Contractor in appropriating the costs to the proper pay item.

##### 4.02 - PAY ITEMS

- A. The name of the following pay item is the abbreviated form of the Bid Item as contained on the Price Schedule in the Bid Forms. The name, as shown below or on the Bid Form, will not be construed to represent a complete description of all or the Work included under such time as is provided only as a means of identification and for ease of conversation.

**ITEM NO.**

**PAYMENT**

2

**Concrete Crack Repair** - Payment will be made at the unit price bid per linear foot of crack repaired and accepted. Include costs for routing existing cracks, debris removal and disposal, transmission of water for surface cleaning, repair materials, application of coatings and mortar, and all work incidental thereto and necessary, therefore.

01021 – UNIT PRICES

- 3**                    **Concrete Spall Repair** - Payment will be made at the unit price bid per square foot of spalls repaired and accepted. Include costs for debris removal and disposal of loose materials to sound substrate, transmission of water for surface cleaning, repair materials, application of coatings, and all work incidental thereto and necessary, therefore.
- 4**                    **Rehabilitation of 8" Drain in Final Sedimentation Tanks** – Payment will be made at the unit price bid per drain that is rehabilitated and accepted. Include costs for debris removal, surface repair and all work incidental thereto and necessary, therefore.
- 5a**                   **Replacement of Flap Valve in North Final Sedimentation Tanks** – Payment will be made at the unit price per flap valve that is replaced and accepted. Include costs for demolition and disposal of existing flap valve, materials for and installation of new flap valve and all work incidental thereto and necessary, therefore.
- 5b**                   **Replacement of Flap Valve in South Final Sedimentation Tanks** – Payment will be made at the unit price per flap valve that is replaced and accepted. Include costs for demolition and disposal of existing flap valve, materials for and installation of new flap valve and all work incidental thereto and necessary, therefore.
- 6**                    **Re-anchoring existing Density Current Baffle, Baffle Plate and/or Weir in Final Sedimentation Tanks** – Payment will be made at the unit price per anchor that is installed and accepted. Include costs for cleaning and preparation of area, removal of existing anchor, materials for and installation of new anchor and all work incidental thereto and necessary, therefore.

END OF SECTION 01021

PART 1 – GENERAL

1.01 DESCRIPTION

- A. General: The Alternates described below shall be included in the Contractor's total bid. Deduction of Alternates shall be in the order that they are listed, and all Alternates deducted from the Contract prior to completion of the Project shall be deducted from final payment made to the Contractor.
- B. Documentation of changes to Contract Sum/Price and Contract Time.

1.02 RELATED PROVISIONS SPECIFIED ELSEWHERE

- A. Proposal Form.
- B. Other sections referencing this section.
- C. All contractual requirements outlined in the documents.

1.03 SUBMISSION REQUIREMENTS

- A. Bid alternates will be provided on the Proposal Form that will identify the effect on adjacent or related components.
- B. Alternates will be reviewed and deducted from the Contract scope at the Owner's option in the order that they are listed.
- C. For alternates deducted from the Contract scope, the Contractor will coordinate related work and modify surrounding work to deduct the Work of each Alternate Bid Item.

1.04 SELECTION AND AWARD OF ALTERNATES

- A. On the Proposal Form, the Contractor will indicate the variation of Bid Price for Alternate Bid Items as listed. The Proposal Form requests a "difference" in Bid Price by deducting from the Base Bid Price.
- B. Alternates quoted on the Proposal Form will be reviewed and accepted at the Owner's option in the order they are listed.
- C. Accepted alternates will be identified in the Owner-Contractor Agreement.
- D. Bids will be evaluated on the Base Bid Price, less alternate items.

1.05 WORK FOR ALTERNATES

- A. Each Alternate shall include all related materials, supplies, labor, equipment and operations necessary to conduct and complete the alternate work and all other affected work or adjacent areas.
- B. There shall be no change in time or completion date for selected alternates, unless specified herein or approved in writing by the Architect/Engineer and Owner.
- C. Alternates and associated work shall meet all standards and specifications delineated in the Contract Documents.

## 01030 – ALTERNATES

- D. Contractor shall coordinate pertinent related Work and modify surrounding Work as required to complete the project under each alternate selected by the Owner.

### PART 2 – PRODUCTS (NOT USED)

### PART 3 - EXECUTION

- A. Work for each alternate, related items and collateral work shall be completed in their entirety.
- B. If alternate items are not deducted from the Contract scope, then all work for the Base Bid and collateral work shall be completed in their entirety.

END OF SECTION 01030

## PART 1 – GENERAL

### 1.01 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 facilities and structures and familiarize himself with the nature and extent to which the existing facilities 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 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 shall 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 09910, 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.

### 1.02 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.

### 1.03 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. Care shall be taken to prevent degradation and damage to materials or equipment to be re-used.

### 1.4 SHORING, UNDERPINNING AND BRACING

- A. When necessary and required, 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, 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 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.

#### 1.06 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.



## 01031 – ADDITIONS, MODIFICATIONS AND ALTERATIONS TO EXISTING BUILDINGS AND STRUCTURES

2. Core drill for individual openings passing through existing concrete slabs and masonry walls. 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 01031

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PART 1 – GENERAL

1.01 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.

## 01039 – DEMOLITION AND REMOVAL OF EXISTING STRUCTURES AND EQUIPMENT

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 013543, Environmental Procedures.
2. Section 01700, Maintenance of Plant Operations.
3. Section 02050, Demolition, Removals and Modifications.

## 1.02 PROTECTION

### A. General:

1. Demolition and removal Work shall be performed by competent workers 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, workers 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, workers 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.

## 1.03 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.

## 01039 – DEMOLITION AND REMOVAL OF EXISTING STRUCTURES AND EQUIPMENT

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.

### 1.04 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.

## 01039 – DEMOLITION AND REMOVAL OF EXISTING STRUCTURES AND EQUIPMENT

- 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.

### 1.05 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 he 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 01039

PART 1 – GENERAL

1.01 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.

01045 – 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 01045



PART 1 – GENERAL

1.01 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.

1.02 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 Engineer 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

1.03 QUALIFICATIONS OF SURVEYOR OR ENGINEER

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

## 01050 – FIELD ENGINEERING

### 1.04 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.

### 1.05 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 01050

PART 1 – GENERAL

1.01 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:
1. AMCA- Air Moving and Conditioning Association, Inc.
  2. AASHTO - American Association of State Highway and Transportation Officials.
  3. ABMA- American Boiler Manufacturers' Association
  4. ACI - American Concrete Institute.
  5. ACIFS- American Cast Iron Flange Standards.
  6. AFBMA- Anti-Friction Bearing Manufacturers Association.
  7. AGA- American Gas Association.
  8. AGMA- American Gear Manufacturers Association.
  9. AIA- American Institute of Architects.
  10. AISC- American Institute of Steel Construction.
  11. AISI- American Iron and Steel Institute.
  12. ANSI - American National Standards Institute.
  13. APA- American Plywood Association.
  14. API- American Petroleum Institute.
  15. ASCE- American Society of Civil Engineers.
  16. ASME- American Society of Mechanical Engineers.
  17. ASTM- American Society for Testing and Materials.
  18. AWPA- American Wood Preservers Association.
  19. AWS- American Welding Society.
  20. AWWA- American Water Works Association.
  21. CGA- Compressed Gas Association.
  22. CRSI- Concrete Reinforcing Steel Institute.
  23. CMAA- Crane Manufacturers' Association of America.
  24. DIPRA- Ductile Iron Pipe Research Association.
  25. EEI- Edison Electric Institute.
  26. EJMA- Expansion Joint Manufacturers' Association.
  27. Fed Spec - Federal Specifications.
  28. FM- Factory Mutual.
  29. HMI- Hoist Manufacturers' Institute.
  30. IEEE- Institute of Electrical and Electronic Engineers.
  31. IPCEA- Insulated Power Cable Engineers Association.
  32. NACE- National Association of Corrosion Engineers.
  33. NB- National Board of Boiler Pressure Vessels.
  34. NBS- National Bureau of Standards.
  35. NEC- National Electric Code.
  36. NEMA- National Electrical Manufacturers Association.
  37. NFPA- National Fire Protection Association.
  38. NYSDOT - New York State Department of Transportation.
  39. OSHA- Occupational Safety and Health Act.
  40. PCA- Portland Cement Association.
  41. PCI- Pre-stressed Concrete Institute.
  42. RMA- Rubber Manufacturers' Association.
  43. SMACCNA - Sheet Metal and Air Conditioning Contractors National Association.
  44. SPI- Society of Plastics Industry.

## 01072 – REFERENCE STANDARDS

- 45. SSPC- Steel Structures Painting Council.
- 46. STI- Steel Tank Institute
- 47. 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 01072

## 01141 – SITE UTILIZATION PLAN

### PART 1 - GENERAL

#### 1.01 SECTION INCLUDES

- A. Site Utilization Plan requirements

#### 1.02 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 01141

+ + NO TEXT ON THIS PAGE + +

PART 1 – GENERAL

1.01 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.

1.02 CONTRACT NUMBER S3C067-08G

- A. Lump Sum Bid - Item No.1: Cedar Creek Water Pollution Control Plant Secondary Treatment Improvements:
  - 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 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.

1.03 UNIT PRICE ITEMS

- A. Unit Price Item Nos. 2 through 6 shall be as listed in the Proposal and in Section 01021. 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.

1.04 ALTERNATES

- A. Alternates will be paid in accordance with the provisions of Section 01030.

1.05 ALLOWANCES

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

1.06 ESTIMATE OF QUANTITIES

- A. The estimated quantities for unit bid prices, as listed in the Proposal, are approximate only and are included solely for the purpose of comparison of Bids. The County does not expressly or by implication agree that the nature of materials encountered below the surface of the ground or the actual quantities of material encountered or required will correspond therewith and reserves the right to increase or decrease any quantity or to eliminate any quantity as the County may deem necessary. The Contractor will not be entitled to any adjustment in the unit bid price as a result of any change in an estimated quantity and agrees to accept the aforesaid unit bid price as complete and total compensation for any additions or deductions caused by a variation in quantities as a result of a more accurate measurement, or by any changes or alterations in the

## 01150 – MEASUREMENT AND PAYMENT

Work approved by the County, and for use in the computation of the value of the Work performed for Partial Payments.

### 1.07 RELATED PROVISIONS ELSEWHERE

A. 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 01150



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 11 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.

## 01300 – SUBMITTALS

- 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:
- E. 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.
1. 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.
  2. 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.
  3. 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.
  4. 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.
  5. 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.
  6. Code 6 - "COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal which provide additional data to aid the Contractor.
  7. Code 7 - "SUBMITTED FOR THE RECORD" is assigned when the contractor has submitted information for record purposes.
  8. 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.

## 01300 – SUBMITTALS

### 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 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.

## 1.09 ADDITIONAL SUBMITTAL REQUIREMENTS

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

## 1.10 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 01300

## 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

\_\_\_\_\_  
(Name of Contractor)

to design \_\_\_\_\_  
(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

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 P6 software, version 16.2 or later.
- E. The Contractor shall retain a CPM Consultant, approved by the Engineer, to assist in the development and preparation of the CPM schedule, and in subsequent schedule updating. The CPM Consultant shall have acceptable certifications such as AACE's Planning & Scheduling Professional (PSP), Project Management Institute's PMI-SP, or approved equal. The CPM Consultant is required to attend the Monthly Schedule Update Meetings. The Contractor is deemed to have included in the Bid price sufficient monies to pay all expenses required to develop the CPM Schedule and to guarantee its successful operation, implementation and maintenance.

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 thirty (30) work days 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

## 01311 – CONSTRUCTION SCHEDULING

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 Diagramming 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 period. 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 he 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. Any project specifics as required by the Engineer.
      - e. 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.



## 01311 – CONSTRUCTION SCHEDULING

- 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 with the exception of 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 a given 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.

## 01311 – CONSTRUCTION SCHEDULING

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) work days of receipt of the Monthly Update approving, approving with comments, or returning for resubmission within five (5) work days.
5. 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.
6. Monthly Schedule Meetings and Reports
  - a. Monthly, on a date established by the Engineer prior to the Data Date, a CPM Progress Meeting will be held, at which time the schedule update will be reviewed. The meeting shall be attended by the Engineer and representative(s) of the Contractor including the scheduling consultant. The Contractor representative(s) at the meetings shall have the competence and authority to make any necessary decisions and their statement shall commit the Contractor to the agreed procedures, sequencing of Work, coordination and time schedules.
  - b. Prior to the meeting, the CPM scheduling consultant shall obtain, through any required means including Site meetings, the necessary information to update the CPM schedule to reflect progress to date and to update/revise the schedule for the balance of the Project. The updated schedule and draft narrative report shall be furnished to the Engineer at least 48 hours prior to the meeting and be distributed by the Contractor in hard copy at the meeting for review. To update the CPM schedule, the Contractor shall:

## 01311 – CONSTRUCTION SCHEDULING

1. Enter actual start and completion dates for those Activities started and/or completed during the previous reporting period
  2. For Activities in progress, indicate the Remaining Duration correlating to an accurate forecasted completion date and physical percentage complete to date (Percent Complete is to reflect the actual quantity of Work completed, and is separate from any actual or Remaining Duration calculation). Review, and revise as necessary, the network logic for the Remaining Duration of the Work from the update to the estimated completion date
  3. For Activities not yet started, review, and revise as required, the necessary Logic, the Durations of Work and the estimated start and completion dates
  4. Enter, for each applicable Activity, actual installed quantities information
  - c. The total Duration to be initially added to any schedule update reflecting the Change Order Activities from identification to the approval of any specific change order shall be in approved by the Engineer and shall be incorporated into the monthly schedule update following the identification of the changed in Work. The forecasted construction Activities shall be logically tied to the appropriate predecessor and successor base Contract Activities and contain all of the required Logic, Duration, Coding and Resource/Cost Loading specified for the detailed CPM schedule activities.
  - d. In the event the Contractor begins performance in the field of Extra Work during the update period, the monthly progress schedule update shall reflect the actual start date of the Work, and any predecessor Logic ties or restraints shall be broken in order to accurately forecast completion of the identified Extra Work Activity. This will allow for accurate forecasting of the successor Work Activities and completion Milestones.
  - e. Default progress data provided from the scheduling system is not be allowed. Actual start and finish dates and Remaining Durations of Activities shall not be automatically updated by default mechanisms that may be included in CPM scheduling software systems. Actual start and finish dates on the CPM schedule shall match those dates provided from the Contractor's Daily Quality Control Reports. Failure of the Contractor to document the actual start and finish dates on the Contractor Daily Quality Control Report for every in-progress or completed Activity and ensure that the data contained on the Contractor Daily Quality Control Reports is the sole basis for schedule updating shall result in the disapproval of the Contractor's submittal.
  - f. Activities that have reported progress without predecessor Activities being completed (out-of-sequence progress) will not be allowed except on a case-by-case basis with the approval of the Engineer. A written explanation for each instance shall be included in the monthly submittal.
  - g. The Contractor shall not constrain the schedule with artificial Logic ties and/or constraint dates and/or any other scheduling techniques that may distort the Activity Float and Total Float associated with the critical path Activities and the schedule in general.
- F. TOTAL FLOAT OWNERSHIP
1. 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
1. 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

1. The Initial Baseline CPM Construction Schedule shall accurately reflect the manner in which 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

1. 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

1. 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. Submit recovery schedule within 10 work days 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:

## 01311 – CONSTRUCTION SCHEDULING

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 per the schedule of values 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 remaining contract period after acceptance. 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 01311

## 01342 – SAMPLES

### PART 1 – GENERAL

#### 1.01 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.

#### 1.02 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 01342

01342 – SAMPLES

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PART 1 – GENERAL

1.01 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, ACGIH
  - 7. Guide to Occupational Exposure Values, ACGIH
- C. Related Specifications
  - 1. Section 01356, Safe and Healthful Working Conditions.

1.02 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

### 2.01 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 selection 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 Unforeseen Hazardous Material Remediation 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

### 3.01 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 Hazardous Materials Remediation Allowance item as described in Section 01020, Allowances.

### 3.02 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.

### 3.03 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.

### 3.04 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.

### 3.05 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.

### 3.06 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.

### 3.07 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 Sedimentation 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.

### 3.08 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.

### 3.09 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 UNFORSEEN 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 01355

+ + NO TEXT ON THIS PAGE + +

PART 1 – GENERAL

1.01 DESCRIPTION

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

1.02 RELATED SPECIFICATIONS

- A. Section 01355, Hazardous Materials Control

1.03 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.

1.04 DEFINITIONS

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

1.05 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.

#### 1.06 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.

#### 1.07 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

#### 2.01 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.

#### 2.02 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 Worker's Compensation Law, he 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.

## 2.03 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.

## 2.04 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.

## 2.05 IDENTIFICATION BADGES

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

## 2.06 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

#### 3.01 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.

#### 3.02 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

## 01356 – SAFE AND HEALTHFUL WORKING CONDITIONS

Protocol notification. All efforts should be made not to schedule site tours/visits at the time of scheduled evacuation drills.

### 3.03 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 01356

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## 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.?

PART 1 - GENERAL

1.01 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.

1.02 RELATED REQUIREMENTS

- A. General Conditions of the Construction Contract

1.03 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 Technical Specification 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:
    - a. The cost of the materials, delivered and unloaded, with all taxes paid. Paid invoices are required for materials upon request by the Engineer.
    - b. The total installed value.
- F. The sum of all values listed in the schedule shall equal the total Contract Sum.

1.04 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.

## 01370 – SCHEDULE OF VALUES

- 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 01370

PART 1 – GENERAL

1.01 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 facility, 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 Monday through Friday, 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 during preparation of the 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.

## 01400 – PROTECTION OF UTILITIES

### 1.02 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.

### 1.03 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.

### 1.04 SUBMITTALS

- A. The Contractor shall submit the proposed utility subcontractor for approval.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 01400

PART 1 – GENERAL

1.01 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.

1.02 MEASUREMENT AND PAYMENT

- A. No separate payment for the item "Job Photographs" will be made. The costs of same shall be included in the Base Bid.
- B. If less than one thousand (1,000) photographs are required, the Contractor shall credit the County fifteen dollars (\$15.00) 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 (\$15.00) for each photographs over one thousand (1,000) photographs.

PART 2 – PRODUCTS

2.01 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 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.

01410 – JOB PHOTOGRAPHS

9. Contractor's name.

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

PART 3 – EXECUTION (NOT USED)

END OF SECTION 01410



## PART 1 – GENERAL

### 1.01 DESCRIPTION

- A. 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.
- B. 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.

### 1.02 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.

### 1.03 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.

### 1.04 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.

#### 1.05 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 Building Official when obtaining the Building Permit.

#### 1.06 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.

#### 1.07 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.

## 01416 – SPECIAL INSTRUCTIONS

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

#### 3.01 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 01416

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01416a – SPECIAL INSPECTION ATTACHMENTS

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:

Building Official's Acceptance:

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

**Schedule of Inspection and Testing Agencies**

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

- |  |  |
|--|--|
| <input type="checkbox"/> Soils and Foundations     | <input type="checkbox"/> Spray Fire Resistant Material         |
| <input type="checkbox"/> Cast-in-Place Concrete    | <input type="checkbox"/> Wood Construction                     |
| <input type="checkbox"/> Precast Concrete          | <input type="checkbox"/> Exterior Insulation and Finish System |
| <input type="checkbox"/> Masonry                   | <input type="checkbox"/> Mechanical & Electrical Systems       |
| <input type="checkbox"/> Structural Steel          | <input type="checkbox"/> Architectural Systems                 |
| <input type="checkbox"/> Cold-Formed Steel Framing | <input type="checkbox"/> 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.
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#### **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
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#### **Other**

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**Soils and Foundations**

Page      of

Item	Agency # (Qualif.)	Scope
1. Shallow Foundations		
2. Controlled Structural Fill		
3. Deep Foundations (Auger Cast Piles)		
4. Load Testing		
4. Other:		



**Cast-in-Place Concrete**

Page      of

Item	Agency # (Qualif.)	Scope
1. Mix Design		
2. Material Certification		
3. Reinforcement Installation		
4. Post-Tensioning Operations		
5. Welding of Reinforcing		
6. Anchor Rods		
7. Concrete Placement		
8. Sampling and Testing of Concrete		
9. Curing and Protection		
10. Other:		

**Precast Concrete**

Page      of

Item	Agency # (Qualif.)	Scope
1. Plant Certification / Quality Control Procedures <input type="checkbox"/> 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: ☐ 1 ☐ 2

Page      of

Item	Agency # (Qualif.)	Scope
1. Material Certification		
2. Mixing of Mortar and Grout		
3. Installation of Masonry		
4. Mortar Joints		
5. Reinforcement Installation		
6. Prestressed Masonry		
7. Grouting Operations		
7. Weather Protection		
9. Evaluation of Masonry Strength		
10. Anchors and Ties		
11. Other:		

**Structural Steel**

Page      of

Item	Agency # (Qualif.)	Scope
1. Fabricator Certification/ Quality Control Procedures  <input type="checkbox"/> Fabricator Exempt		
2. Material Certification		
3. Open Web Steel Joists		
4. Bolting		
5. Welding		
6. Shear Connectors		
7. Structural Details		
8. Metal Deck		
9. Other:		

**Cold-Formed Steel Framing**

Page      of

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






**Mechanical & Electrical Systems**

Page      of

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

**Architectural Systems**

Page      of

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

Special Cases

Page      of

Item	Agency # (Qualif.)	Scope

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

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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.

## PART 1 – GENERAL

### 1.01 DESCRIPTION

- A. Scope: 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

### 1.02 SUBMITTALS

- A. Submit Spill Prevention and Control to the Engineer.

### 1.03 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. Include a Project Telephone Directory in 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

## 01495 – SPILL PREVENTION AND CONTROL

- 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

#### 3.01 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 Conservation, Nassau County Department of Health, Nassau County Department of Public Works, and the Engineer within two hours of the release or spill.

#### 3.02 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.

#### 3.03 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.

END OF SECTION 01495



PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. Temporary facilities and controls shall be provided in the manner designated hereinafter at the project site.
- 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.

1.02 TEMPORARY WATER AND SANITARY FACILITIES

- A. The Contractor shall provide and pay all costs for temporary toilet facilities in sufficient numbers, for the Contractor's and Subcontractors' 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 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 and disposed of in a satisfactory manner, as the occasion requires.
- C. The Contractor shall rigorously prohibit the nuisances within, on, or about the Work.
- D. County Sanitary Facilities and Locker rooms are prohibited from Contractors' and subcontractors' use.

1.03 TEMPORARY ELECTRICAL 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:

## 01500 – TEMPORARY FACILITIES AND CONTROLS

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 the north west corner of the aeration deck inside the West Pipe Gallery approximately 150 feet from the stairwell 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 LED, 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 with clearance above vehicular traffic. 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 1.03 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, furnish, install and maintain such additional temporary lighting and power facilities at 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 installed so as not to interfere with the work of other Contractors.
3. Upon completion of the work under contract, remove all additional facilities installed.

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 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 1.04.
- 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.

#### 1.05 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 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 1.05, Temporary Heating Facilities.
  4. Ventilation air shall be heated to those temperatures specified for space or room temperatures as hereinbefore specified in Paragraph 1.05, 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 1.05.
- 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.

#### 1.06 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/her workers 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 site.
    - 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, he 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.



## 01500 – TEMPORARY FACILITIES AND CONTROLS

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 outside of the work area.
- 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, at his 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.

### 1.07 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 before 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.

#### 1.08 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.

## 01500 – TEMPORARY FACILITIES AND CONTROLS

### 1.09 SECURITY

- A. It shall be the responsibility of the Contractor to make whatever provisions deemed 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 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 01500

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## 01516 – TEMPORARY FIRE PROTECTION

### PART 1 – GENERAL

#### 1.01 DESCRIPTION

- A. Scope:
  - 1. The Contractor shall provide temporary fire protection at the Cedar Creek WPCP, for all areas where work under this Contract is being performed and throughout the Project, until the project is completed. Remove temporary fire protection when the project is completed.
  - 2. The Contractor shall comply with Section 901.7 and 1404.5 of the Fire Code of New York State.
  - 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.

#### 1.02 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.

#### 1.03 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 01516

01516 – TEMPORARY FIRE PROTECTION

+ + NO TEXT ON THIS PAGE + +

PART 1 – GENERAL

1.01 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.

1.02 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.

1.03 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."

1.04 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."

1.05 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 Prevention Plan.

1.06 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.

## 01560 – ENVIRONMENTAL CONTROLS

- 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.

### 1.07 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.

### 1.08 HAZARDOUS MATERIALS CONTROL

- A. Refer to Section 01355, Hazardous Materials Control.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 01560



PART 1 – GENERAL

1.01 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. 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 requirements and testing called for in Section 05050 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 he has good title to all materials and supplies used by him in the Work, free from all liens, claims or encumbrances.

1.02 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.

1.03 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 statutes, 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.

#### 1.04 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 05050.

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.

#### 1.05 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.

#### 1.06 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.

## 01600 – MATERIALS AND EQUIPMENT

- 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 01600

01600 – MATERIALS AND EQUIPMENT

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## PART 1 – GENERAL

### 1.01 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.

### 1.02 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.

### 1.03 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.

## 01610 – TRANSPORTATION AND HANDLING OF MATERIALS AND EQUIPMENT

- 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.

### 1.04 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.

### 1.05 COORDINATE STORAGE AND INSTALLATION

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

### 1.06 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 01610



## PART 1 – GENERAL

### 1.01 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. Provide filters, chemicals, and other expendables required for initial startup of equipment unless otherwise specified.

### 1.02 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:

## 01650 – STARTING OF SYSTEMS

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.

### 1.03 INITIAL FACILITIES 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

## 01650 – STARTING OF SYSTEMS

approval of the Engineer. Startup of the facilities 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 01650

01650 – STARTING OF SYSTEMS

+ + NO TEXT ON THIS PAGE + +

PART 1 – GENERAL

1.01 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.

1.02 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.

## 01660 – QUALITY CONTROL

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 01660

PART 1 – GENERAL

1.01 GENERAL

- A. The intent of this Section is to have Contractor perform the 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.
- 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
  - 2. Section 01500, Temporary Facilities and Controls.
  - 3. Section 02050, Demolition, Removals and Modifications.

1.02 GENERAL CONSTRAINTS

- A. Paragraph 1.05 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 at the 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. Plant Water System: The existing plant water system shall be kept in operation at all times.
  7. 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.
  8. Storm Drainage: Storm drainage on the site shall be operational at all times.
  9. 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.
  10. 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.
  11. 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.
  12. 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.

### 1.03 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



## 01700 – MAINTENANCE OF PLANT OPERATIONS

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 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.

### 1.04 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.

### 1.05 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 01700

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## Detailed Maintenance of Plant Operations (MOPO) Descriptions

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## MAINTENANCE OF PLANT OPERATIONS

Item Number:	Item Description:	Time Constraints:	Phasing Requirements:	General definition of Work to be performed:
1	Remove and dispose of existing Return Activated Sludge (RAS) pumps and associated valves of the RAS Pump Station and provide new RAS Pumps and associated valves	90 consecutive calendar days (CCD) per two or three RAS pumps	Three RAS pumps and associated valves at one Pump Station shall be taken out of service at one time for replacement. At the completion of the commissioning of the three RAS pumps, three RAS pumps and associated valves at the other Pump Station shall be taken out of service at one time for replacement. Once completed, the remaining two RAS Pumps at each Pump Station shall be consecutively completed. The first six RAS pump upgrades shall be completed first, prior to any other work being completed.	Coordinate RAS Pump Station upgrades, see Sequence of Construction Item 1 for specific requirements
2	Rehabilitate Final Sedimentation Tanks (FSTs) and associated upstream and downstream piping instruments	150 consecutive calendar days (CCD) per two concurrent FSTs	Two FSTs (one North FST and one South FST) and its associated piping can be taken out of service for rehabilitation at one time for the complete duration of the contract.	Coordinate FST system upgrades, see Sequence of Construction Item 2 for specific requirements
3	Remove and dispose of existing Return Activated Sludge (RAS) flow meters located downstream of the North and South RAS Pump Stations and provide new RAS flow meters	8-hour shift	Two (2) RAS flow meters can be taken out of service at one time for the complete duration of the contract	Coordinate RAS flow meter work, see Sequence of Construction Item 3 for specific requirements
4	Remove and dispose of existing North Return Activated Sludge (RAS) Pump Station wet well level sensors and provide new North RAS Pump Station wet well level sensors	N/A	New level sensors shall be installed and fully operational prior to removal and disposal of existing bubbler systems.	Coordinate RAS level sensor work, see Sequence of Construction Item 4 for specific requirements
5	Remove and dispose of existing Waste Activated Sludge (WAS) flow meters and pump seal water pressure sensors and provide new flow meters and pump seal water pressure sensors	N/A	One WAS pump and associated flow meter, and sensor can be taken out of service at one time. One north WAS pump, and one south WAS pump must always be in service.	Coordinate WAS system upgrades, see Sequence of Construction Item 5 for specific requirements
6	(ADD-ALT-1 & ADD-ALT-2): Remove and dispose of existing Low-Pressure Air (LPA) dissolved oxygen sensors, flow meters, control valves and actuators and provide new LPA dissolved oxygen	60 consecutive calendar days (CCD) per aeration tank shut down, or 30 CCD per	Four passes of the aeration tank can be taken out of service at one time for flow meter and valve replacement throughout the duration of this project except for during hurricane season (i.e. June 1 through November 30). During hurricane season,	Coordinate LPA system upgrades, see Sequence of Construction Item 6 for specific requirements

# 01700A – DETAILED MOPO DESCRIPTIONS

	sensors, flow meters, control valves and actuators	aeration system	only two aeration tank passes can be taken out of service at a time.	
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**GENERAL NOTE:** The existing secondary treatment process must remain fully operational during construction. Any construction/demolition that effects the existing secondary treatment process must be coordinated, 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: Remove and dispose of existing Return Activated Sludge (RAS) pumps and associated valves of the RAS Pump Station and provide new RAS Pumps and associated valves***

1. Owner's operator shall close the existing 24" suction isolation valve and 18" discharge isolation valve on one (1) RAS pump at one pump station. Contractor to note the existing isolation valves are not watertight and should not be considered reliable for a long duration. Items 1 through 3 should be completed within one 8-hour shift.
2. Contractor shall remove the RAS pump, check valve, piping and appurtenances on the out of service RAS pump line.
3. New 24"x12" reducer, 12" suction knife gate valve and 18" discharge knife gate valve shall be installed on the out of service RAS pump line as indicated on the contract documents.
4. Items 1 through 3 shall be repeated to decommission three (3) pumps and associated appurtenances at one pump station. If there are not three currently out of service pumps, it shall be up to the Owner or Owner's operator to select which three pumps get replaced.
5. Contractor shall install the following equipment and instruments as indicated on the contract documents per pump for each of the three isolated pump locations with the new suction and discharge valves. All three pumps and associated equipment shall be installed, fully functional, and commissioned prior to any other work being performed on this project. All work described in item 5 shall be completed in ninety (90) CCD.
  - a. RAS Pump
  - b. Check Valve
  - c. Pressure Gauge and Switch (2)
  - d. Air Release Valve
  - e. VFD
  - f. Reducers and Piping
  - g. Control Panel upgrades
6. Steps 1 through 5 shall be repeated for three (3) RAS Pumps at the other RAS Pump Station. Once six (6) RAS Pumps are operational and commissioned, concurrent work shall be allowed in other areas of the Plant as part of this project.
7. Steps 1 through 5 shall be repeated for the remaining two (2) RAS Pumps at one RAS Pump Station. Once completed, steps 1 through 5 shall be repeated for the remaining two (2) RAS Pumps at the other RAS Pump Station.

***Item 2: Rehabilitate Final Sedimentation Tanks (FSTs) and associated upstream and downstream piping instruments***

1. FST no. 12 shall be the first FST to be rehabilitated of the South FSTs and FST no. 5 shall be the first FST to be rehabilitated of the North FSTs. FST no. 11 shall be the last FST of the South FSTs to be rehabilitated. There is no other sequence restrictions for the rehabilitation of the remaining FSTs.
2. Coordinate isolation and draining of each FST with Owner's operator. Owner's operators will close the 36-inch diameter influent sluice gate located at the influent distribution box/chamber associated with the FST to be rehabilitated to isolate the FST from influent flow. Once the residual liquid content level in the FST is low enough, the Owner's operators will remove the 8" drain caps located in each FST to drain the remainder of the contents within the FST. Contractor shall be responsible for tank cleaning after contents are drained as noted on the plans and specified. (see note 4 below)

3. Coordinate isolation of all RAS flow to associated RAS Pump Station from FST no. 1 through no. 6 or FST no. 9 through no. 14 with Owner's operator. **Duration of flow isolation to the RAS Pump Station wet well shall not exceed one 8-hour shift to complete the activities listed in bullets a. through f. below.**
  - a. Owner's operator will close all isolation valves located upstream of the RAS flow meter from FST no. 1 through no. 6 or FST no. 9 through no. 14 to prevent RAS from continuing to enter the RAS Pump Station wet well.
  - b. Owner's operator will pump down the contents from the RAS Pump Station wet well using the existing RAS Pump Station pumps to the lowest level possible.
  - c. For North RAS Pump Station:
    - i. Contractor shall enter the wet well from the two (2) 5'-0" x 2'-6" openings at El. 18.5 and deploy a SCUBA diver to enter the dewatered wet well via accessway and install an inflatable plug within the influent RAS line of the offline FST.
  - d. For South RAS Pump Station:
    - i. Contractor shall un-bolt and remove the solid access cover from the side wall of the South RAS Pump Station, located within the West Pipe Gallery, and deploy a SCUBA diver to enter the dewatered wet well via accessway and install an inflatable plug within the influent RAS line of the offline FST.
    - ii. Contractor shall reinstall the solid access cover to the side wall of the South RAS Pump Station and seal to provide watertight connection, following successful installation of the plug and retrieval of the SCUBA diver from the wet well.
  - e. Owner's operator shall reopen the isolation valves located upstream of the RAS flow meters and restart the RAS Pump Station pumps. Owner's operator shall close the five tank drain valves not associated with the current FST out of service.
  - f. The temporary inflatable plug shall remain within the RAS Pump Station inlet pipe until the next associated FST is taken out of service to perform the rehabilitation.
  - g. This process shall be repeated six (6) times or until all flow meters and valves scheduled on the plans, located upstream of the RAS Pump Station are replaced.
4. Contractor shall dewater and clean the FST and associated influent piping of residual deleterious materials and wastewater. See specification 02513 – High Pressure Water Cleaning for cleaning requirements. The residual deleterious materials from the FST shall be emptied into the existing tank drain (i.e. 20" effluent RAS pipe and two (2) 8" tank drains). All other native residual material shall be disposed of to a plant drain to send the material to the head of the plant. Plant drain locations shall be verified in the field with the Owner's operator. Any materials generated by and/or introduced to the tank contents by the Contractor shall be legally disposed of off-site.
5. Contractor shall manually open all sixteen (16) flap valves around the perimeter of the tank wall and install inflatable plugs to prevent any groundwater from entering the tank. While the plugs are installed, the flap valves shall be replaced as indicated on the Contract Documents. Plugs shall not be removed until the FST is approved by Owner's operator and Engineer to be refilled for testing and commissioning.
6. Demolish and dispose of the following equipment as identified on the Contract Documents:
  - a. FST Clarifier equipment
  - b. Influent FST flow meter and transmitter
  - c. Influent FST butterfly valve and electric actuator
  - d. RAS flow meter and transmitter located downstream of the FST and upstream of the RAS Pump Station Wet Well
  - e. RAS Isolation Valve #1 located upstream of the RAS flow meter
  - f. RAS Isolation Valve #2 located downstream of the flow meter and upstream of the RAS Pump Station Wet Well
  - g. RAS Control Valve
  - h. RAS Tank Drain Valve

7. Contractor shall be responsible for the residual contents within the isolated section of RAS piping.
8. Perform concrete repairs within the offline FST, as required, and directed by the Engineer.
9. Rehabilitate the 8" drains located in the floor of the offline FST.
10. Install new clarifier equipment, influent flow meter and transmitter, influent butterfly valve and electric actuator, RAS flow meter and transmitter and valves located downstream of the FST as identified on the Contract Documents.
11. Install new 2" grout on the floor and effluent launder of the FST.
12. Perform electrical and control work as required for complete installation.
13. Perform required testing, commissioning, and start-up services.
14. Once the rehabilitation is completed, coordinate with the Owner's operator to bring the rehabilitated FST and associated piping back into service.
15. The remaining FSTs shall not be interrupted and shall be always accessible to the Owner's operator for operations and maintenance activities for the duration of the contract.

***Item 3: Remove and dispose existing Return Activated Sludge (RAS) flow meters located downstream of the North and South RAS Pump Stations and install new RAS flow meters***

1. The RAS flow meters to be replaced under this MOPO are located at Pass A and Pass C upstream of the Aeration Tanks no. 1 – 6. **Up to two (2) RAS flow meters can be taken out of service for a maximum duration not to exceed one 8-hour shift to complete the activities listed in bullets a. through d. below for an online aeration tank. Alternatively, up to two (2) RAS flow meters can be taken out of service if their replacement coincides with the low-pressure air MOPO detailed in Item 6 below (only if Add Alternate 1 is selected).**
  - a. Coordinate isolation of two (2) RAS flow meters with Owner's operator. To perform this work, the RAS flow to the selected aeration tanks will need to be temporarily taken out of service by the Owner's operator who shall isolate the RAS flow meters using existing valves located upstream and downstream of each flow meter.
  - b. Remove and dispose of the existing flow meters and transmitters as identified on the Contract Documents. Contractor shall be responsible for containing the residual deleterious materials and wastewater remaining within the isolated portion of piping and dispose of said contents to a plant drain to send the material to the head of the plant. Plant drain locations shall be verified in the field with the Owner's operator.
  - c. Install new flow meter and transmitter as identified on the Contract Documents.
  - d. Coordinate reintroduction of RAS flow through the isolated sections of piping with the Owner's operator should the flow meter be connected to an online aeration tank and perform electrical and control work to complete installation after flow is reintroduced. Should the flow meter be connected to an offline aeration tank, then disregard this step and proceed from bullet c. above to bullet 2 below.
2. Perform electrical and control work as required for complete installation. New flow meters servicing an online aeration tank must be fully operational and integrated with existing plant controls within 5 CCDs starting from the day flow is reintroduced through the meter.
3. Once the work is completed, coordinate with the Owner's operator to reintroduce RAS flow in conjunction with bringing the aeration tank system back online.
4. The remaining RAS system shall be kept in service and shall be accessible to the Owner's operator for operations and maintenance activities for the duration of the contract.

***Item 4: Remove and dispose of existing North Return Activated Sludge (RAS) Pump Station wet well level sensors and install new North RAS Pump Station level sensors***

1. New level sensors and transmitters shall be installed as identified on the Contract Documents.



2. Perform electrical and control work as required for complete installation of new level sensor devices.
3. The existing bubbler system shall remain in use until the new level sensors are installed, tested and fully operational.
4. The existing bubbler system shall be removed and disposed of from each wet well including the bubbler panel and any exposed piping and appurtenances located outside and/or within the electrical room including the compressed air piping and exposed stilling well located above the top slab of the North RAS Pump Station wet well. Abandon in place the existing stilling well materials located inside the North RAS Pump Station wet well.
5. The entire North RAS Pump Station shall be kept in service and shall be accessible to the Owner's operator for operations and maintenance activities for the duration of the contract.

***Item 5: Remove and dispose of existing Waste Activated Sludge (WAS) flow meters and pump seal water pressure sensors and install new flow meters and pump seal water pressure sensors.***

1. Coordinate isolation of each WAS pump with Owner's operator. The flow meters are located downstream of each WAS pump and the seal water pressure gauges are connected to the seal water system for each WAS pump. The associated WAS pump will be not in service to perform this work. One pump serving the north FSTs and one pump serving the south FSTs shall be always kept in service.
  - a. WAS pump no. 1 services only the north FSTs.
  - b. WAS pumps no. 2 and no. 3 can service either north or south FSTs.
  - c. WAS pump no. 4 services only the south FSTs.
  - d. Owner's operator will operate the required valves to isolate the pump that is not in service.
2. Remove and dispose of the existing flow meter, transmitter and pump seal water pressure gauge associated with the isolated WAS pump as identified on the Contract Documents. Any residual sludge/wastewater from the removal of the flow meter shall be contained and disposed of by the Contractor to a plant drain to send the material to the head of the plant. Plant drain locations shall be verified in the field with the Owner's operator.
3. Install new flow meter and transmitter and pump seal water pressure sensor associated with the isolated WAS pump as identified on the Contract Documents.
4. Perform electrical and control work as required for complete installation.
5. Once the work is completed, coordinate with the Owner's operator to bring the WAS flow meter and pump back into service.
6. The remaining WAS system shall be kept in service and shall be accessible to the Owner's operator for operations and maintenance activities for the duration of the contract.

***Item 6: (ADD-ALT-1 & ADD-ALT-2) Remove and dispose of existing Low-Pressure Air (LPA) dissolved oxygen sensors, flow meters, control valves and actuators and install new LPA dissolved oxygen sensors, flow meters, control valves and actuators***

1. Coordinate isolation of the low-pressure process air to aeration tank passes with Owner's operator. Owner's operator will isolate and drain the aeration tank passes. Owner's operator will also operate the required valves to isolate the low-pressure air to the aeration tank pass piping. Once the aeration tank is out of service, the Contractor can begin work on the low-pressure air system.
  - a. Two passes and up to four passes (during non-hurricane season) of the aeration tanks can be taken out of service at one time. The aeration tanks operate as a two-pass system. Passes A and B are one aeration system and can be isolated at one time. Passes C and D are one aeration system and can be isolated at one time.
2. Remove and dispose of the existing dissolved oxygen sensors, flow meter(s) and transmitter(s) and control valve(s) and actuator(s) associated with the aeration tank pass and grids that are out of service.

## 01700A – DETAILED MOPO DESCRIPTIONS

3. Install new dissolved oxygen sensors, flow meter(s) and transmitter(s), control valve(s) and actuator(s) associated with the aeration tank pass and grid that is out service as identified on the Contract Documents.
4. Perform electrical and control work as required for complete installation.
5. Once the work is completed, coordinate with the Owner's operator to bring the aeration tank pass back into service.
6. The remaining LPA system shall be kept in service and shall be accessible to the Owner's operator for operations and maintenance activities for the duration of the contract.

END OF SECTION 01700A

## 01710 – CLEANING

### PART 1 – GENERAL

#### 1.01 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 01710

01710 – CLEANING

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PART 1 – GENERAL

1.01 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."

1.02 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.

1.03 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.

1.04 FINAL SUBMISSION OF RECORD DOCUMENTS

- A. Record Drawings:

## 01720 – PROJECT RECORD DOCUMENTS

1. At the completion of the Work, Contractor shall furnish to the Engineer record drawings one (1) reproducible media set and on USB thumb drive, (1) electronic bound AutoCAD drawing set in Release 2012 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 Cedar Creek 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 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 shall be submitted for approval of the Engineer. This shall include the following composite drawings for the system being furnished:
    - a. Schematic (Electrical) 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 01720

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. Four copies plus word and PDF files 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 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-inch by 11-inch; paper shall be sixty (60) pound and reinforced holes 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 and a searchable PDF file 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.

<b>SAMPLE MAINTENANCE SCHEDULE</b>			
<b>Item</b>	<b>Action</b>	<b>Frequency</b>	<b>Remarks</b>

<b>SAMPLE LUBRICATION SCHEDULE</b>				
<b>Item</b>	<b>Manufacturer's Recommendations</b>	<b>Type Lubricant</b>	<b>Quantity Per Tank</b>	<b>Frequency</b>

#### 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 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 to cause minimum disruption to the total plant operation.
- F. Upon completion of a minimum of ten consecutive twenty-four (24)-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. General:
  1. Manufacturer shall provide the services of factory trained specialists to instruct the County's operation and maintenance personnel in recommended operation and corrective and preventive maintenance procedures for equipment as specified in

the respective equipment Section and outlined in the attached schedule at the end of this Section. Training shall be scheduled prior to start-up of the equipment.

2. The qualifications of the specialists shall be subject to approval by the County's representative.
3. Manufacturer shall be responsible for coordinating these services at times acceptable to the County, with a minimum of 14 days prior notice, after an approval of the Lesson Plan.
4. Manufacturer shall provide a combination of classroom, equipment site, and machine shop training. All training shall be conducted at the Cedar Creek Water Pollution Control Plant unless otherwise specified.
5. Manufacturer shall provide the minimum training for each piece of equipment as specified in the attached schedule.
6. The County reserves the right to videotape all manufacturer training sessions.

B. Submittals:

1. Manufacturer shall submit for approval proposed Lesson Plans for the instruction prior to scheduling training. Lesson plans shall include operations, mechanical maintenance, and electrical and instrumentation maintenance as outlined in the attached schedule at the end of this section.
2. Manufacturer shall submit for approval credentials of their designated instructors with the Lesson Plan Submittals. Credentials shall include a brief resume and specific details of the instructor's experience with operation and maintenance of and training on the equipment specified.

C. Instruction Lesson Plans:

1. Manufacturer's proposed Lesson Plans shall include the elements presented in the Training Instruction Lesson Plans in Paragraph 1.7,C.4, and any other information necessary for proper operation and maintenance of the equipment. Specific components and procedures shall be identified in the proposed Lesson Plan.
2. Manufacturer's proposed Lesson Plans shall detail specific instruction topics. Training aids to be utilized including handouts, in the instruction shall be referenced and attached to the proposed Lesson Plan. "Hands-On" demonstrations planned for the instruction shall be described in the Lesson Plans.
3. The manufacturer shall indicate the estimated duration of each segment of the training Lesson Plans and the training audience the instruction is to address.
4. Training Instruction Lesson Plans: Guide for Equipment Maintenance:
  - a. Maintenance Training:
    - 1) System Overview.
      - a) Describe the function and performance objectives of the equipment or system.
      - b) Describe the main features of the equipment or system.
      - c) Identify all support system and related auxiliary equipment.
    - 2) Preventive Maintenance (PM):
      - a) Define the recommended PM program and schedules for each system and equipment item.
      - b) Describe PM procedures.
      - c) Describe inspection and test procedures and use of test equipment, if applicable.
      - d) Describe routine inspection procedures required to:
        - i. Perform an inspection of equipment while it is operating.
        - ii. Identify symptoms of potential problems to anticipate breakdowns.
      - e) Describe equipment housekeeping procedures,

- f) Equipment Troubleshooting:
        - g) Define recommended systematic troubleshooting procedures.
        - h) Provide component-specific troubleshooting checklists.
        - i) Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.
    - 3) Equipment Corrective Maintenance:
      - a) Describe recommended equipment preparation requirements.
      - b) Identify and describe the use of any special tools required for maintenance of the equipment.
      - c) Describe component removal/installation and disassembly/assembly procedures.
      - d) Perform at least two "hands-on" demonstrations of common corrective maintenance repairs.
      - e) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
      - f) Define recommended torque, mounting, calibration, and/or alignment procedures and settings, as appropriate.
      - g) Describe recommended procedures to check/test equipment following a corrective repair.
  - b. Operations Training:
    - 1) System Overview:
      - a) Describe the function and performance objective of the equipment or system.
      - b) Describe the main features of the equipment or system.
      - c) Identify all support systems and related auxiliary equipment.
    - 2) Operation:
      - a) Describe operating principles and practices.
      - b) Describe routine operating, startup, and shutdown procedures.
      - c) Describe alarm conditions and response to alarms. Identify safety features and control interlocks.
      - d) Describe routine monitoring and record keeping procedures.
- D. Responsibilities:
- 1. Manufacturer's Instructors shall be fully prepared for the training sessions. Training delivery shall be communicative, clear and proceed according to the approved lesson plan material covered shall be appropriate for the personnel in attendance. If training delivery is found by the County or Engineer to be not to Standards or requirements, the training shall be postponed and rescheduled at a cost to be borne by the Contractor.
- E. Training Schedule and Operation & Maintenance Manuals: To 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
11335	Sedimentation Tank Equipment	16 hours
13420	Non-Contact Radar Level Meter	4 hours
13420	Magnetic Type Flow Meters	8 hours

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13420	Differential Pressure for Flow Elements	4 hours
13420	Dissolved Oxygen Analyzer	4 hours
13420	Gauge Pressure Transmitters	2 hours
15100	Butterfly Valves	4 hours
15100	Gate Valves	4 hours
15101	Valve Actuator - Powered	4 hours

END OF SECTION 01730

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PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Requirements for construction waste management.

1.02 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 NYSDEC Part 364 Waste Transporter Permit. The permit must authorize the transporter to take the hazardous

## 01733 – CONSTRUCTION WASTE MANAGEMENT

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

#### 3.01 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.

#### 3.02 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 01733



## PART 1 - GENERAL

### 1.01 - SUMMARY

- A. Testing of piping.
- B. Testing of tanks vented to atmosphere.
- C. Pipe leakage testing shall comply with the conditions noted in the Schedule.

### 1.02 - DEFINITIONS

- A. Leakage (or exfiltration) - The quantity of water to be supplied into the newly laid pipe, any valved section thereof, manhole, or other appurtenance, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.
- B. Infiltration - The quantity of water that enters into any pipe, manhole, or other appurtenance when the static groundwater elevation is at the maximum elevation above the pipe or appurtenance as specified hereinafter.

### 1.03 - QUALITY ASSURANCE

- A. Prior to Substantial Completion, pressure pipes and non-pressure pipes shall meet specific leakage requirements. These leakage requirements shall be satisfied by the basic materials alone. Where joint fillers and the like have been specified, primarily to protect jointing materials, and secondarily to provide a factor of safety, they shall not be applied until after leakage tests have been completed and have been accepted by Engineer.
- B. Engineer will witness all tests. Tests not witnessed will be considered as not having been performed.
- C. Do not close or cover up work until it has been observed for proper and satisfactory construction and installation in compliance with the Contract Documents. Should incomplete or unacceptable work be covered, the Contractor shall, at his/her own expense, uncover all work so that it may be properly observed. After such observations, repair and replace the work that was found defective, unsatisfactory, and not in accordance with the Contract Documents. After such repair and replacement, bring all work to completeness and status as it was before it was closed and covered, all at the Contractor's own expense. Submit for review and approval proposed corrective action to correct failed systems.
- D. Successful completion of required tests shall be in no way interpreted as relieving the Contractor of responsibility for defects that become apparent subsequent to the time of testing. It shall be

the sole right of the Engineer/Architect to determine whether defects exist. Retest all portions of the work deemed necessary by the Engineer/Architect prior to Substantial Completion.

#### 1.04 - SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Provide details and specifications on testing apparatus.
- C. Provide certified test results on forms approved by the Engineer/Architect.

#### 1.05 - SEQUENCING AND SCHEDULING

- A. Notify Engineer/Architect and governing agencies, if necessary, at least 48 hours in advance of a scheduled test so that the test may be witnessed.
- B. Test underground pipe prior to backfilling.
- C. At Engineer/Architect's discretion, additional sections of pipelines may be required to be tested as soon as pipe is laid and prior to backfilling when working conditions or the standard of workmanship have been altered.

### PART 2 - PRODUCTS

#### 2.01 - TESTING APPARATUS

- A. Provide labor, plugs, measuring equipment, and other apparatus, complete, to perform testing.
- B. Provide clean water, air, nitrogen, and other materials as required to accomplish testing.
- C. Provide plugs and caps capable of withstanding test pressures.
- D. Provide temporary flanges, plugs, bulkheads, thrust blocks, weighing, bracing and other items necessary to prevent joints from separating, and to prevent injuries or damage.

### PART 3 - EXECUTION

#### 3.01 - PREPARATION

- A. Plug open ends, adequately block bends, tees, ends, and other fittings, and do whatever is necessary to brace piping system so that it will safely withstand the pressures developed under the tests and so that no damage or injury shall occur to the pipeline, people or property.

- B. Before tests are conducted, isolate, or remove any regulator, gauge, trap, or other apparatus or equipment that may be damaged by test pressures.

### 3.02 - GENERAL

- A. Trapped Air: Trapped air may cause a false indication of the rate of leakage. Points of concern include ends of lines, stubs, house connections and high points in pipelines. No credit will be made for this condition and no adjustment will be made to the allowable leakage. When trapped air is suspected of causing a test failure, do whatever is necessary to evacuate the air and repeat tests until the actual leakage is equal to or less than allowable rate of leakage.
- B. Water Absorption: No credit will be given for absorption of water in pipe and manhole walls. If necessary, fill pipes and manholes with water well in advance of testing and allow them to soak in order to eliminate or minimize the effects of absorption.

### 3.03 - TESTS FOR NON-PRESSURE PIPING

- A. General:
  - 1. Leakage shall be determined by exfiltration testing. The Engineer/Architect reserves the right to also require infiltration testing.
  - 2. Air testing is not permitted.
  - 3. Leakage testing shall include the main non-pressure pipe, house connections, and appurtenances on the section of pipeline being tested.
  - 4. Limit pipeline test sections to runs between adjacent structures. Manholes may be tested simultaneously with pipes.
  - 5. Adequately plug ends of house connections, stubs, and openings from which water may escape.
  - 6. Use clean water for exfiltration tests.
  - 7. Determine groundwater levels by installing piezometers, test holes or test pits at intervals not to exceed 1,000 feet.
- B. Pipe Exfiltration Test:

1. The minimum water level required for testing is 4 feet above the crown of the upstream (highest) end of the pipe being tested or 2 feet above the maximum groundwater level along the test section, whichever is greater.
2. Install a watertight plug in the downstream end of the manhole pipe.
3. Fill upstream manhole with water and conduct test for six (6) hours.
4. Upon satisfactorily completing the test, remove the downstream plug in the presence of Engineer/Architect. Do not touch nor remove anything until approved by Engineer/Architect.
5. Maximum allowable exfiltration is one hundred (100) gallons per inch diameter per mile per day.

C. Pipe Infiltration Test:

1. The minimum head of groundwater required for infiltration testing is 2 feet above the crown of the pipe at the upstream end but must in all cases reach its normal level.
2. Infiltration may be measured with an approved graduated container capable of intercepting all inflow, by a pipeline V-notch weir, or by other approved methods. When using instream type measuring devices, do not measure flows until steady state conditions are established.
3. Maximum allowable infiltration is one hundred (100) gallons per inch diameter per day per mile of pipe.
4. Where groundwater level is at least 2 feet above the highest manhole joint, manholes may be included in the test. No visible leakage will be permitted in manholes.

3.04 - TESTS FOR PRESSURE PIPES

- A. Leakage testing shall include the main exiting pipe, service connections, and other appurtenances on the section of pipeline being tested.
- B. Test pipes prior to applying insulation and before they are concealed or furred-in.
- C. Provide all necessary gauges. Gauges shall be standard pressure type with a minimum 6 inch diameter dial and a pressure range not in excess of 150% of the maximum required test pressure.

- D. Provide and maintain at the site a gauge stand with an approved laboratory calibrated test gauge. Periodically check test gauge used for testing against the test gauge, and whenever requested by Engineer.
- E. Where it is necessary for testing, tap pipes and insert approved plugs after testing is completed.
- F. Provide a hand or motor driven compressor to maintain the required test pressure constant throughout the duration of the test. If a water pump is used, pump water from a container with a known volume of water. If an air or inert gas pump is used, leakage shall be determined and calculated by the cycling of the pump.
- G. Provide test gauges at each end of the line being tested.
- H. Conduct leakage test in accordance with the requirements contained in the Schedule.

### 3.05 - ALLOWABLE LEAKAGE

- A. The maximum allowable leakage for the various piping systems is presented in the schedule.
- B. It is the intent of this Contract to secure piping systems without leakage.
  - 1. Each section of pipe and within each structure shall not exceed the allowable leakage.
  - 2. It is also the intent to secure a piping system free from visible drips, streams and leaks. Therefore, even if a portion of the system meets the requirements for allowable leakage, visible leaks are not permitted and shall be repaired.
- C. Leakage tests will be considered satisfactorily passed when the rate of leakage is equal to or less than the stipulated allowances, there is no evidence of visible leaks, and there is no evidence of other system defects.

### 3.06 – TEST FOR TANKS VENTED TO ATMOSPHERE

- A. Prior to testing liquid holding tanks open to the atmosphere, backfill to finished grade. Piping and equipment within the tank that might affect the watertightness of the tank shall be completely installed and operable.
- B. Isolate each individual tank for testing.
  - 1. Fill with clean, potable water to the maximum operating level.

2. After a suitable stabilization period, the maximum operating level shall be reestablished and a twenty-four (24) hour leakage test shall be performed.
  3. During the test, no water shall be added to or taken from the tank. The drop in the water level shall be recorded at the end of the period.
  4. The allowable loss is no more than 1/4-inch per eight hours and no running leaks shall be visible.
  5. Leaks shall be repaired by methods and materials approved by the Engineer prior to the start of the corrective action.
  6. Leakage shall be corrected prior to the performance of equipment testing.
  7. During the testing of each individual tank, as outlined in this paragraph, all immediately adjacent tanks shall be empty of water.
- C. After each individual tank has passed the leakage test, all tanks within each complex shall be filled with water to the normal operation level to check complex structural integrity and the hydraulics of operation.

### 3.07 - RETESTING

- A. Pipes, tanks and manholes not passing the tests shall have all defects corrected with methods approved by the Engineer/Architect to the inspection and satisfaction of Engineer/Architect, and shall be retested and re-corrected as often as is necessary until the test requirements have been met.
- B. It is the intent of this Contract to obtain work meeting test requirements on their own and solely through the use of the normal integral sealing components.
1. Joint leaks shall not be stopped using concrete, caulking, mortar, or other patching materials.
  2. Leaking pipe joints shall be re-jointed and leaking manhole joints shall have joints reset, or replaced if necessary.
- C. Methods other than rejoining, resetting or replacing joint seals shall require the written approval of Engineer/Architect.

## 3.08 - SCHEDULE

LEAKAGE TESTING REQUIREMENTS

SERVICE	FLUID	PRESSURE	DURATION (Hrs.)	ALLOWABLE LEAKAGE (Note 1)		
				UNDERGROUND		EXPOSED
				Infil.	Exfil.	
Non-Pressure Piping	Water	4ft.	6	100	100	None
Pressure Piping	Water	(Note 2)	(Note 2)	0	0	0

SCHEDULE NOTES:

1. Maximum allowable leakage in gallons/day/inch diameter per mile of pipe, or gallons/day/inch diameter/mile for manholes. Where a percentage is shown, the loss shall not exceed the percentage of the starting test pressure.
2. Maintain 100 psi or two times operating pressure, whichever is greater, for 2 hours.

END OF SECTION 01755

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PART 1 – GENERAL

1.01 FINAL CLEANING

- A. At the completion of the Work, the Contractor shall remove temporary structures, construction signs, tools, scaffolding, materials, supplies and equipment which he or any of his 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.

1.02 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 01760

01760 – PROJECT CLOSEOUT

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01770 – MINORITY/WOMEN'S BUSINESS ENTERPRISE PROGRAM AND EQUAL EMPLOYMENT  
OPPORTUNITY REQUIREMENTS

PART 1 – GENERAL

1.01 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:
1. 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.
  2. 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.
  3. 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.
  4. 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).
  5. The Contractor shall be bound by the provisions of Section 109 of Local law No. 14-2002 (entitled "Enforcement").
  6. 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.
  7. 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.
  8. 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.
  9. 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,

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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.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 01770

## PART 1 - GENERAL

### 1.01 - SUMMARY

- 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. Final Sedimentation Tank Clarifier System
  - 2. RAS Pumps
  - 3. Instrumentation and Control / SCADA System
  - 4. Butterfly Valves with Actuators
  - 5. Exhaust Fans
  - 6. 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.
- B. 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 it 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

- A. Verify the functions of the clarifier control panel including torque and motor alarms.
- B. Verify Instrumentation and Control / SCADA System are operating as required.
- C. Verify level and flow measurement devices are accurate.

## 01812 – COMMISSIONING SUMMARY

- 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 pump in each wet well to demonstrate operation of lag pumps.
- H. Turn off lead and lag pumps in each wet well to demonstrate operation of high water and high-high water level alarms at pump panel and to alarm system.
- I. Manually pump down wet well to demonstrate operation of low-level alarm at pump panel and to alarm system.
- J. Demonstrate operation of spare wastewater pump.
- K. Conduct 5-day test to demonstrate operation of entire pump station.

END OF SECTION 01812

## PART 1 - GENERAL

### 1.01 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.

### 1.02 SUBMITTALS

#### A. Schedule: Submit for approval the following:

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

### 1.03 PROTECTION

#### A. General:

1. Demolition and removal Work shall be performed by competent workers 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, workers 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, workers 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 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.
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

3.01 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. Disposition 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.
  - 2. 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.
  - 3. 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.
- F. 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.

### 3.02 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.

### 3.03 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.

### 3.04 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.

### 3.05 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.

### 3.06 MODIFICATIONS AND CLOSURES

- A. Modifications shall conform to all applicable Specifications, the Drawings, and the directions and approvals of the Engineer.



## 02050 – DEMOLITION, REMOVALS, AND MODIFICATIONS

- 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 and coat cut ends with zinc rich primer.
- 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.

### 3.07 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.

### 3.08 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.

### 3.09 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 containers for collection of waste materials, debris and rubbish, 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 02050

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## 02110 – SITE CLEARING

### PART 1 - GENERAL

#### 1.01 - SECTION INCLUDES

- A. Remove and dispose of surface debris as required.
- B. Remove and dispose of paving, sidewalk, curbs, etc.
- C. Clear site or designated areas of the site of plant life and grass as required and dispose of as required.
- D. Remove and dispose of trees and shrubs as required.
- E. Remove and dispose of stumps and root system of trees and shrubs as required.
- F. Removal and storage of topsoil.

#### 1.02 - RELATED SECTIONS

- A. Section 02200 - Earthwork.
- B. Section 02485 – Lawns and Grasses.

#### 1.03 - REGULATORY REQUIREMENTS

- A. Conform to applicable local code(s) for disposal of debris.
- B. Burning of materials on site is prohibited.
- C. Coordinate clearing work with utility companies.

### PART 2 – PRODUCTS (NOT USED)

### PART 3 - EXECUTION

#### 3.01 - PREPARATION

- A. Verify existing conditions.
- B. Identify existing plant life designated to be removed. Verify with Owner and Engineer prior to removal.
- C. Verify limits of clearing.

#### 3.02 - PROTECTION

- A. Locate, identify and protect utilities that are to remain from damage.
- B. Protect trees, plant growth and features designated to remain as final landscaping.
- C. Protect benchmarks and existing structures from damage or displacement. Any damage to existing structures is to be promptly repaired at no additional cost to the Owner.

## 02110 – SITE CLEARING

### 3.03 - APPLICATION

- A. Clear areas required for access to site and execution of work.
- B. Remove paving, curbs, debris and sidewalks as required.
- C. Remove trees and shrubs designated to be removed. Remove stumps, main root ball, surface rock and perishable debris.
- D. Clear undergrowth and dead wood without disturbing subsoil.
- E. Remove paving, debris, rock and extracted plant life from site and dispose of in accordance with State and local ordinances.
- F. Excavate topsoil from areas to be further excavated, re-landscaped or regraded. Do not excavate wet topsoil.
- G. Stockpile topsoil in area designated on site to a height not exceeding 8 feet. Protect from erosion. Remove excess topsoil not being reused from site. Do not remove any topsoil from the site prior to obtaining the approval of the Engineer.

END OF SECTION 02110

## PART 1 - GENERAL

### 1.01 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 available on-site sources.
3. Crushed stone materials shall be obtained from off-site sources.
4. Topsoil shall be obtained from off-site sources.

#### C. Related Sections:

1. Section 02050, Demolition, Removals and Modifications.
2. Section 03300, Cast-In-Place Concrete.

### 1.02 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 A 36, Structural Steel.
2. ASTM A 328, Steel Sheet Piling.
3. ASTM D 422, Particle-Size Analysis of Soils.
4. ASTM D 698, Moisture-Density Relations of Soils, using 5.5 lb (2.5 kg) Rammer and 12-inch (304.8 mm) Drop.
5. ASTM D 1556, 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 D 422.
  - b. Compacted Select Fill: Compaction, ASTM D 698 and ASTM D 1556.
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.

#### 1.03 SUBMITTALS

- A. Contractor shall prepare drawings for the following items:
  1. Sheeting and bracing, or other protective system(s).
  2. 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. 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.

#### 1.04 JOB CONDITIONS

- A. Site Information:
  1. 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 operations and maintain the area of 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

## 2.01 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

## 2.02 FILTER FABRIC:

- A. Filter fabric shall be placed below or under the drainage material as shown on the Drawings.
- B. Filter fabric shall be a non-woven polypropylene material, needle punched or spunbonded fabric.
- C. Filter fabric material, of non-woven plastic cloth meeting the following requirements, shall be installed as shown on the Contract Drawings.

<b>Equivalent Opening Size</b>	80-100 (U.S. Standard Sieve)
<b>Open Area (%)</b>	20-40
<b>Pore Size Range (MM)</b>	0.10 To 0.18
<b>Thickness (mils)</b>	30
<b>Grab Strength (lbs)</b>	120 (Minimum)
<b>Grab Elongation (%)</b>	70
<b>Burst Strength (psi)</b>	125
<b>Trapezoid Tear Strength (lbs)</b>	70
<b>Water Permeability</b>	
<b>Coefficient (K-cm/sec)*</b>	0.07
<b>Water Flow Rate (gal/min-ft<sup>2</sup>)</b>	480
<b>Weight (ms/m<sup>2</sup>)</b>	140 (Minimum)

\*According to CFMC-FFET-2, "Falling-Head Water Permeability of Filter Fabrics".



- D. Filter fabric shall be Mirafi 140S as manufactured by the Celanese Fibers Marketing Company, Celanese Corporation, or equal.

## 2.03 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 (CCA).
- B. Steel Sheeting:
  - 1. Temporary Work: Steel conforming to ASTM A 328. Steel for soldier piles, wales and braces may be new or used and shall conform to ASTM A 36.
  - 2. Permanent Work: New or used rolled steel sections of the continuous interlocking type, conforming to ASTM A 328.
- 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

### 3.01 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.

### 3.02 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.

### 3.03 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.

### 3.04 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:
    - a. Unrotted straw or salt hay - 1-1/2 to 2 tons/acre.
    - b. 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.

### 3.05 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, shored and braced as shown on the plans and 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 or 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 90 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.

### 3.06 SHEETING, SHORING AND BRACING

- A. General:
1. Sheet piling, shoring and bracing shall be used where shown, and where necessary to prevent injury to workers, structures, or pipe lines. Jetting for sheet piling 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 sheet piling 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, sheet piling, 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 sheet piling 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 sheet piling as shown. Cut off tops as required, but at least 2-feet below finished grade.
  6. The clearances and types of the temporary sheet piling, 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 sheet piling, 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.

### 3.07 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 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.
  - 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. Make all repairs and replacements necessary within 30 days after notice from the Engineer.

### 3.08 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.

### 3.09 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. Do 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. Maintain, in good and safe condition during progress of the entire Work, the surface of the paved area over the excavation, and 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.
- 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 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.

END OF SECTION 02200

02200 – EARTHWORK

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## 02231 – CRUSHED STONE AGGREGATE BASE COURSE

### PART 1 - GENERAL

#### 1.01 SECTION INCLUDES

- A. Crushed stone aggregate base course.

#### 1.02 RELATED SECTIONS

- A. Section 02200 - Earthwork.

#### 1.03 REFERENCES

- A. ANSI/ASTM C88 - Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- B. ANSI/ASTM C136 - Sieve Analysis of Fine and Coarse Aggregates.
- C. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb Rammer and 18-inch Drop.
- D. ASTM D4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

#### 1.04 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Test Reports: Submit a sieve analysis for the aggregate base course used.

#### 1.05 DELIVERY, STORAGE and HANDLING

- A. Deliver, store and handle products to the site under provisions of Section 01650.
- B. Do not handle aggregate in any manner which will cause segregation of large or fine particles.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Coarse Aggregate: Angular, crushed, natural stone with crushed stone screenings; free of shale, clay, friable materials and debris; graded in accordance with ANSI/ASTM C136 within the following limits:

Sieve Size	% Passing
1-1/2 inches	100
1 inch	90-100
1/2 inch	65-85
3/8 inch	55-75
No. 4	40-55
No. 8	30-45
No. 16	22-36
No. 30	16-27
No. 50	12-19
No. 100	7-13
No. 200	3-7

## 02231 – CRUSHED STONE AGGREGATE BASE COURSE

- B. Material retained on the 1/2 inch sieve is coarse aggregate.
- C. Coarse aggregate when subjected to 5 cycles of the soundness test in accordance with ANSI/ASTM C88 shall have a weight loss of not more than 5 percent with sodium sulfate or 10 percent with magnesium sulfate.
- D. The portion of the aggregate base course which passes the No. 50 screen shall have a plasticity index of zero as tested in accordance with ASTM D4318.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Verify existing conditions and substrate.
- B. Verify elevations of subgrade are as indicated on the plans.
- C. Verify that subgrade is properly compacted and ready to receive work of this section.
- D. Beginning work of this section means acceptance of existing conditions.

#### 3.02 PREPARATION

- A. Fine grade and compact subgrade to 95 percent maximum dry density in accordance with ANSI/ASTM D1557.

#### 3.03 AGGREGATE PLACEMENT

- A. Spread course aggregate over prepared subgrade to a total compacted thickness as indicated on the plans.
- B. Place aggregate in 3 inch layers and compact by roller.
- C. Level and contour surfaces to elevations and gradients indicated.
- D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.
- E. Compact placed aggregate materials to 95% maximum dry density in accordance with ANSI/ASTM D1557. Maintain optimum moisture content to attain required density.
- F. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- G. Use mechanical vibrating tamping in areas inaccessible to compaction equipment.
- H. Place new pavement on the properly compacted aggregate base course within 24 hours of final compaction. If aggregate base course is left open for more than 24 hours, recompact and retest in accordance with ANSI/ASTM D1557.

#### 3.04 TOLERANCES

- A. Maximum Variation From Flatness: 1/4 inch measured with 10 foot straight edge.
- B. Maximum Variation From Scheduled Compacted Thickness: 1/4 inch.

## 02231 – CRUSHED STONE AGGREGATE BASE COURSE

- C. Maximum Variation from True Elevation: 1/4 inch.

### 3.05 FIELD QUALITY CONTROL

- A. Compaction testing will be performed in accordance with ANSI/ASTM D1557.
- B. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to Owner.
- C. Frequency of Tests: One test per 500 sq ft. immediately prior to paving.

END OF SECTION 02231

02231 – CRUSHED STONE AGGREGATE BASE COURSE

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## 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 Conservation.
  - 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 Documents. 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 Owner.
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 Owner.
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



## 02272 – SOIL EROSION AND SEDIMENT CONTROL

3. Topsoil Stabilization Matting
  4. Dust Retardant
- B. Submit certificate from geotextile manufacturers that geotextiles comply with the 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. Unless otherwise shown on the Contract Drawings, geotextiles shall have a maximum Apparent Opening Size of 0.6 mm. and minimum permeability of  $1 \times 10^{-3}$  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 wire mesh shall be galvanized and contain 4 inch square 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 updrift 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 updrift 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 with 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 it 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 erodable 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 or 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

## 02272 – SOIL EROSION AND SEDIMENT CONTROL

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 02272

## PART 1 - GENERAL

### 1.01 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 02110, Site Clearing.
  - 2. Section 02200, Earthwork.

### 1.02 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 C 602, Agricultural Liming Materials.
  2. ASTM D 2487, Classification of Soils for Engineering.
  3. Association of Official Analytical Chemists, Official Methods of Analysis.
  4. Official Seed Analysts 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.

### 1.03 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.
  4. Certificates of inspection substantiating that sod contains no noxious weeds or other material that might be detrimental to the proposed planting.

### 1.04 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.

#### 1.05 GUARANTEE

- A. Guarantee turf through the specified maintenance period.

#### 1.06 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

#### 2.01 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, freeflowing 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.

<b>MIXTURE A</b>				
<b>Proportions of Mixture</b>	<b>Mixture Tolerance</b>		<b>Germination Tolerance</b>	
	<b>Minus</b>	<b>Plus</b>	<b>Germination</b>	<b>Minus</b>
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.

<b>MIXTURE B</b>				
<b>Proportions of Mixture</b>	<b>Mixture Tolerance</b>		<b>Germination Tolerance</b>	
	<b>Minus</b>	<b>Plus</b>	<b>Germination</b>	<b>Minus</b>
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 Weyerhaeuser 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

#### 3.01 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.

#### 3.02 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 turfed 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.

### 3.03 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" 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 thoroughly 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.

### 3.04 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.

### 3.05 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.

### 3.06 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 02485

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PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Asphaltic concrete paving; wearing, binder or base course.

1.02 RELATED SECTIONS

- A. Section 02231 – Crushed Stone Aggregate Base Course.

1.03 REFERENCES

- A. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot Mix Types.
- B. AI MS-8 - Asphalt Paving Manual.
- C. ASTM D242 - Mineral Filler for Bituminous Paving Mixtures.
- D. ASTM D546 - Test Method for Sieve Analysis of Mineral Filler for Road and Paving Materials.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Supplier: Submit name of asphalt supplier to be used on the project prior to placement of any asphalt on the project.
- C. Design Data: Submit asphalt mix design for each asphalt type to be used.
- D. Testing Firm: Submit name of testing firm to be performing tests on asphalt pavement.

1.05 QUALITY ASSURANCE

- A. Obtain materials from the same supplier throughout the duration of the project.
- B. Do not alter from mix design requirements.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle products to the site under provisions of Section 01610.
- B. Deliver asphalt in sealed, metal containers covered with suitable material to protect the asphalt from the elements.
- C. Lightly lubricate the inside surface of the container with a thin oil or soap solution before loading asphalt.
- D. All containers must be cleaned of all foreign materials prior to loading.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not place asphalt when base surface temperature is less than 40 degrees F, or if surface is wet or frozen.
- B. Do not place asphalt when precipitation is occurring.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Asphalt Cement: AC-20; homogeneous, and shall not foam when heated to 347 degrees F.
- B. Fine Aggregate: Material passing the 1/8 inch sieve; natural sand of hard, strong, durable particles which are free from coatings or injurious amounts of clay, loam or other deleterious substances.
- C. Coarse Aggregate: Material retained on the 1/8 inch sieve; crushed stone or gravel; clean, durable, sharp angled fragments of rock of uniform quality.
- D. Mineral Filler: ASTM D242, finely ground particles of limestone, hydrated lime or other mineral dust, free of foreign matter; 100 percent shall pass the No. 30 sieve; a minimum of 85 percent shall pass the No. 80 sieve; and a minimum of 65 percent shall pass the No. 200 sieve as measured in accordance with ASTM D546.

### 2.02 EQUIPMENT

- A. Rollers: Minimum weight of 10 tons; equipped with lubricating devices for the roller wheels.
- B. Pavers: Equipped with a vibratory device.

### 2.03 ACCESSORIES

- A. Tack Coat: Homogeneous, medium curing, liquid asphalt.
- B. Wheel Lubricant: Oil-water mixture containing maximum 10 percent lubricating oil.

### 2.04 MIXES

- A. Use dry material to avoid foaming. Mix uniformly.
- B. Base Course: NYSDOT Type 1; 4.0 to 6.0 percent of asphalt cement by weight in mixture in accordance with the following gradation:

Sieve Size	Percent Passing
2 inches	100
1 ½ inches	90-100
1 inch	78-95
½ inch	57-84
¼ inch	40-72
1/8 inch	26-57
No. 20	12-36
No. 40	8-25
No. 80	4-16
No. 200	2-8

- C. Binder Course: NYSDOT Type 3; 4.5 to 6.5 percent of asphalt cement by weight in mixture in accordance with the following gradation:

Sieve Size	Percent Passing
1-1/2 inches	100
1 inch	95-100
1/2 inch	70-90
1/4 inch	48-74
1/8 inch	32-62
No. 20	15-39
No. 40	8-27
No. 80	4-16
No. 200	2-8

- D. Wearing Course: NYSDOT Type 6; 5.8 to 7.0 percent of asphalt cement by weight in mixture in accordance with the following gradation:

Sieve Size	Percent Passing
1 inch	100
1/2 inch	95-100
1/4 inch	65-85
1/8 inch	36-65
No. 20	15-39
No. 40	8-27
No. 80	4-16
No. 200	3-6

## 2.05 SOURCE QUALITY CONTROL

- A. Obtain asphalt materials from same source throughout the project.
- B. Provide asphalt in accordance with the approved mix design for each type of asphalt.
- C. Test samples in accordance with AI MS-2.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Verify existing conditions and substrate.
- B. Verify that compacted subbase is dry and ready to receive work of this section.
- C. Verify gradients and elevations of base are correct.
- D. Verify that all castings are properly installed and are at the correct elevations.
- E. Beginning of installation means installer accepts existing conditions.

### 3.02 PREPARATION

- A. Apply tack coat at uniform rate of 0.03 to 0.07 gal/sq. yd. to contact surfaces of castings, curbs, gutters and any asphalt or concrete material.
- B. Do not apply tack coat to wet or frozen surfaces.

- C. Coat top surfaces of castings with oil to prevent bond with asphalt pavement.

### 3.03 INSTALLATION

- A. Install work in accordance with AI MS-8.
- B. Maintain asphalt temperature between 250 and 325 degrees F during placement.
- C. Place asphalt within 24 hours of applying tack coat.
- D. Place asphalt to compacted thicknesses as identified on plans. If a multiple course pavement is to be used, place top course within 24 hours of placing bottom course. If more than 24 hours elapse, a tack coat will be required to be placed over the entire surface of the bottom course prior to any additional paving.
- E. Utilize the vibratory device on the paver at all times.
- F. Compact pavement by rolling. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- G. Compact pavement to a minimum of 94% maximum density.
- H. Develop rolling with consecutive passes to achieve even and smooth finish, without roller marks.
- I. Seal all joints between new pavement and existing pavement with asphalt cement.

### 3.04 TOLERANCES

- A. Maximum Variation From Flatness: 1/8 inch measured with 10 foot straight edge.
- B. Maximum Variation From Scheduled Compacted Thickness: 1/8 inch.
- C. Maximum Variation from True Elevation: 1/4 inch.

### 3.05 FIELD QUALITY CONTROL

- A. Take samples and perform tests in accordance with AI MS-2.
- B. Test are to include percent compaction, gradation and asphalt content.
- C. Provide an asphalt thermometer for determining the asphalt temperature during paving operations.
- D. Frequency of Tests: One test for every 1,000 square feet of each pavement course.

### 3.06 PROTECTION

- A. Protect finished work under provisions of Section 01500.
- A. Immediately after placement, protect pavement from mechanical injury until project is accepted by the Owner.

END OF SECTION 02510

PART 1 – GENERAL

1.01 - SECTION INCLUDES

- A. Pressure washing requirements.

1.02 – RELATED SECTIONS

- A. Section 01039 – Demolition and Removal of Existing Structures and Equipment
- B. Section 01710 – Cleaning

1.03 – REFERENCES

- A. NACE No. 5/SSPC-SP12 (HP-WC) – Surface Preparation and Cleaning by Water jetting Prior to Recoating

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 - EXAMINATION

- A. Verify site conditions and tank details.

3.02 - PREPARATION

- A. Provide rigging/access to allow working of all areas of the tank.
- B. All tank openings shall be adequately protected during power washing to prevent any spray, dirt or debris from entering tank openings or piping.
- C. All debris generated during pressure washing activities shall be collected and retained on site. All debris shall be disposed of in accordance with all State, Federal and Local Laws.

3.03 - APPLICATION

- A. All interior/exterior surfaces of the tank shall be pressure washed.
- B. All water, sediment and debris shall be removed from tank interior after high pressure water cleaning is performed.
- C. Water pressure shall be a 4,000 – 5,000 psi as measured at the tip of the nozzle at the area of surface being cleaned. Contractor shall use the means necessary to accomplish the level of cleanliness less than 70µs/cm or as directed by engineer.
- D. Water shall be of a minimum temperature of 120-150°F and shall be capable of removing loosely adhered coatings, mill scale, corrosion, accumulated dirt, mildew, algae, loose/flaking /poorly adhered concrete, efflorescence and calcium deposits. Water temperature shall be maintained with hot water or steam generator.
- E. Stubborn staining shall be removed by soft bristle scrub brush. All exterior tank surfaces shall be cleaned with a mildewcide cleaning solution to remove all mildew, algae, biological growth, etc.

## 02513 – HIGH PRESSURE WATER CLEANING

- F. Work shall progress such that completed sections are not soiled by subsequent activities
- G. Any damage to the tank or site due to cleaning activities shall be restored by the Contractor at his own expense. Concrete tank profile and edges shall be maintained during cleaning activities.

### 3.04 - FIELD QUALITY CONTROL

- A. Perform cleaning under provisions of Section 01710.
- B. Do not perform pressure washing when temperatures may create ice formation or when wind conditions will create a nuisance to adjacent properties and buildings.

END OF SECTION 02513

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Concrete sidewalks, handicap ramps, driveway aprons.
- B. Formwork.

1.02 RELATED SECTIONS

- A. Section 02200 - Earthwork.

1.03 REFERENCES

- A. ACI 301 - Structural Concrete for Buildings.
- B. ANSI/ASTM A1064 – Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- C. ANSI/ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.
- D. ASTM C33 - Concrete Aggregates.
- E. ASTM C94 - Ready Mix Concrete.
- F. ASTM C150 - Portland Cement
- G. ASTM C260 - Air-Entraining Admixtures for Concrete.
- H. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
- I. ASTM C494 - Chemical Admixtures for Concrete.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide data on joint filler, admixtures and curing compounds.
- C. Supplier: Submit name of concrete supplier prior to the placement of any concrete on the project.
- D. Design Data: Provide a design mix for each type of concrete to be used on the project.
- E. Certificates: Submit receipts of all concrete deliveries, indicating source, date, contractor, amount of concrete, concrete strength, truck number and time load was batched.
- F. Testing Firm: Submit name of testing firm to be performing tests on concrete.

1.05 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01720.
- B. Accurately record locations of each day's concrete pour.

## 1.06 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. Obtain concrete only from approved suppliers and maintain the same source throughout the project.

## 1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle products to the site under provisions of Section 01650.
- B. Deliver concrete in accordance with ASTM C94, Alternative No. 2.
- C. Place all concrete within 90 minutes of time load was batched.

## 1.08 ENVIRONMENTAL REQUIREMENTS

- A. Do not place concrete when base surface temperature is less than 40 degrees F, or if surface is wet or frozen.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Cement: ASTM C150, air entraining, Type 1A Portland, gray color.
- B. Aggregates: ASTM C33.
- C. Water: Potable and not detrimental to concrete.
- D. Reinforcement: ANSI/ASTM A1064 plain welded steel wire fabric; in flat sheets; uncoated finish.

### 2.02 ACCESSORIES

- A. Forms: Douglas Fir plywood type; solid, sound, undamaged sheets.
- B. Joint Filler: ANSI/ASTM D1751; 1/2 inch thick.
- C. Air Entraining Admixture: ASTM C260.
- D. Chemical Admixture: ASTM C494, type as required.
- E. Curing Compound: ASTM C309, Type 1, Class A.
- F. Form Release Agent: Colorless material which will not stain concrete or absorb moisture.
- G. Detectable Warning Surface: SAFTI-TRAX Mats or equal.

### 2.03 MIXES

- A. Concrete shall be mixed and prepared in accordance with the approved mix design and ASTM C94, Alternative No. 2.
- B. The mix shall be such that the concrete shall attain the following characteristics:
  - 1. Compressive Strength (28 days): 4,000 psi.



2. Slump: 2½ to 3½ inches.
  3. Air Entrainment: 6% ±1%.
- C. Use chemical admixtures only when approved by the Engineer. Use of admixtures will not relax placement requirements.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Verify existing conditions and substrate.
- B. Verify datum and all elevations are as indicated on the plans.
- C. Verify compacted granular subbase has been properly prepared and is ready to receive work of this section.
- D. Beginning of installation means installer accepts existing conditions.

#### 3.02 PREPARATION

- A. Compact base to minimum 95 percent maximum dry density in accordance with ANSI/ASTM D1557.
- B. Moisten base to a minimum depth of 1/2 inch to minimize absorption of water from fresh concrete.
- C. Coat surfaces of manhole and catch basin frames with oil to prevent bond with concrete pavement.
- D. Place and secure forms to correct location, dimension and profile.
- E. Assemble formwork to permit easy stripping and dismantling without damaging concrete. Coat forms with form release agent.

#### 3.03 INSTALLATION

- A. Place joint filler vertical in position in straight lines. Secure to formwork during concrete placement.
- B. Place reinforcement as indicated on the plans. Interrupt reinforcement at expansion joints.
- C. Place concrete in accordance with ACI 301.
- D. Ensure reinforcement and formed joints are not disturbed during concrete placement.
- E. Place concrete continuously between predetermined construction joints. Do not break or interrupt successive pours such that joints occur.
- F. Vibrate concrete adjacent to forms.
- G. Place concrete to pattern indicated.
- H. Place expansion joints with joint filler at 20 foot intervals.
- I. Place scored contraction joints at 4 foot intervals.

## 02521 – PORTLAND CEMENT CONCRETE SIDEWALK

- J. Place joint filler between paving components and building or other appurtenances and in expansion joints.
- K. Apply a light broom finish perpendicular to traffic.
- L. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

### 3.04 FIELD QUALITY CONTROL

- A. Take six concrete test cylinders for every 50 cu. yds. or fraction thereof of each class of concrete placed each day.
- B. Cure test cylinders on site under same conditions as concrete sidewalk.
- C. Take one slump test for each set of test cylinders taken.
- D. Concrete not meeting slump requirements will be rejected.
- E. Concrete represented by cylinders which do not meet required strength will be removed and replaced at no additional cost to the Owner.

### 3.05 PROTECTION

- A. Protect finished work under provisions of Section 01500.
- B. Immediately after placement, protect sidewalk from premature drying, excessive temperatures and mechanical injury.
- C. Protect sidewalk from damage until project is accepted by the Owner.

END OF SECTION 02521

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Reinforced concrete curb.
- B. Formwork.

1.02 RELATED SECTIONS

- A. Section 02200 - Earthwork.

1.03 REFERENCES

- A. ACI 301 - Structural Concrete for Buildings.
- B. ANSI/ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.
- C. ASTM A615 - Deformed and Plain Billet Steel for Concrete Reinforcement.
- D. ASTM C33 - Concrete Aggregates.
- E. ASTM C94 - Ready Mix Concrete.
- F. ASTM C150 - Portland Cement
- G. ASTM C260 - Air-Entraining Admixtures for Concrete.
- H. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
- I. ASTM C494 - Chemical Admixtures for Concrete.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Product Data: Provide data on joint filler, admixtures and curing compounds.
- C. Supplier: Submit name of concrete supplier prior to the placement of any concrete on the project.
- D. Design Data: Provide a design mix for concrete to be used on the project.
- E. Certificates: Submit receipts of all concrete deliveries, indicating source, date, contractor, amount of concrete, concrete strength, truck number and time truck load was batched.
- F. Testing Firm: Submit name of testing firm to be performing tests on concrete.

1.05 PROJECT RECORD DOCUMENTS

- A. Accurately record locations of each day's concrete pours.

#### 1.06 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. Obtain concrete only from approved suppliers and maintain the same source throughout the project.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver concrete in accordance with ASTM C94, Alternative No. 2.
- B. Place all concrete within 90 minutes of time load was batched.

#### 1.08 ENVIRONMENTAL REQUIREMENTS

- A. Do not place concrete when base surface temperature is less than 40 degrees, or if surface is wet or frozen.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Cement: ASTM C150, Type 1 Portland, gray color.
- B. Aggregates: ASTM C33.
- C. Water: Potable and not detrimental to concrete.
- D. Reinforcement: ANSI A615 steel; 60 ksi yield grade; deformed billet steel bars; uncoated finish.
- E. Dowels: ASTM A615 steel; 60 ksi yield grade; plain steel, uncoated finish.

#### 2.02 ACCESSORIES

- A. Steel Forms: Minimum 16 gauge thick, stiffened to support weight of concrete with a minimum deflection.
- B. Wood Forms: Douglas Fir species; solid, sound, undamaged sheets; minimum 2 inches (50 mm) thick.
- C. Joint Filler: ANSI/ASTM D1751; 1/2 inch thick.
- D. Air Entraining Admixture: ASTM C260.
- E. Chemical Admixture: ASTM C494, type as required.
- F. Curing Compound: ASTM C309, Type 1, Class A.
- G. Form Release Agent: Colorless material which will not stain concrete or absorb moisture.

#### 2.03 MIXES

- A. Concrete shall be mixed and prepared in accordance with the approved mix design and ASTM C94, Alternative No. 2.

- B. The mix shall be such that the concrete shall attain the following characteristics:
  - 1. Compressive Strength (28 days): 4,000 psi.
  - 2. Slump: 2½ to 3½ inches.
  - 3. Air Entrainment: 6% ±1%.
- C. Use chemical admixtures only when approved by the Engineer. Use of admixtures will not relax placement requirements.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Verify existing conditions and substrate.
- B. Verify datum and all elevations are as indicated on the plans.
- C. Verify compacted granular subbase has been properly prepared and is ready to receive work of this section.
- D. Beginning of installation means installer accepts existing conditions.

#### 3.02 PREPARATION

- A. Excavate to the required depth and compact surface.
- B. Place and secure forms to correct location, dimension and profile.
- C. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- D. Moisten base to a minimum depth of 1/2 inch to minimize absorption of water from fresh concrete.
- E. Coat forms with form release agent.

#### 3.03 INSTALLATION

- A. Place joint filler vertical in position and at equal spaces not exceeding 20 feet. Secure to formwork during concrete placement.
- B. Place dowels through joint filler as indicated on the plans. One end of dowel is to be greased or set in a capped sleeve to allow longitudinal movement.
- C. Place reinforcement as indicated on the plans. Interrupt at expansion joints.
- D. Place concrete in accordance with ACI 301.
- E. Ensure reinforcement, dowels, joint filler or forms are not disturbed during concrete placement.
- F. Place concrete continuously between construction joints. Do not break or interrupt successive pours such that cold joints occur.
- G. Vibrate concrete adjacent to forms.
- H. After concrete sets, but prior to curing, remove front forms without damaging concrete and apply a light broom finish to the top and face of the curb.

## 02522 – PORTLAND CEMENT CONCRETE CURB

- I. Place curing compound on exposed surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

### 3.04 FIELD QUALITY CONTROL

- A. Take six concrete test cylinders for every 50 cu. yds. or fraction thereof of concrete placed each day.
- B. Cure test cylinders on site under same conditions as curb.
- C. Take one slump test for each set of cylinders taken.
- D. Concrete not meeting slump requirements will be rejected.
- E. Concrete represented by cylinders which do not meet required strength will be removed and replaced at no additional cost to the Owner.

### 3.05 PROTECTION

- A. Protect finished work under provisions of Section 01500.
- B. Immediately after placement, protect curb from premature drying, excessive temperatures, rain and mechanical injury.
- C. Protect curb from damage until project is accepted by the Owner.

END OF SECTION 02522

PART 1 – GENERAL

1.01 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 embedments, 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.

1.02 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.

1.03 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.
- B. Mock-Ups for Concrete Finishes: Provide forming for mock-ups as required for finish work shown and specified for the Work. Place embedded materials in mock-up. Construct forms using facing materials such as form liners, where required, to provide specified finishes and to the requirements specified in Section 03300, Cast-In-Place Concrete. Obtain Engineer's acceptance of each mock-up prior to starting forming for the Work. Do not remove mock-up(s) until directed by Engineer.

#### 1.04 SUBMITTALS

- A. Action Submittals: Submit the following:
  - 1. Samples:
    - a. Plywood form material used for smooth form finish, four inches square minimum.
    - b. Form liner section sufficiently large to show two full repeating patterns, at least 12 inches square.
    - c. Controlled permeability forming liner material, eight inches square, minimum.
    - d. Form Liner Sample Panel:
      - 1) Sample shall show texture and surface pattern, required backing, form tie treatment, and treatment at liner panel joints. Use form material to be used in the Work.
      - 2) Minimum Size: Three feet by four feet.
- 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.

#### 1.05 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

### 2.01 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.

### 2.02 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. Forms for Architecturally Finished Concrete:

1. Form finish concrete surfaces with units of face design, size, arrangement, and configuration as shown or as required to comply with approved Project job mock-up. Provide solid backing and form supports to ensure stability of form liners.
  2. Form Material: Overlaid plywood in accordance with NIST PS 1. Provide B-B high density overlaid concrete form, Class I.
  3. Form Liners: Rigid PVC or fiberglass in pattern shown or indicated.
  4. Form Reuse: To be determined by Engineer at time of installation.
  5. Rustication Joints: Rigid PVC in profile shown or indicated.
  6. Panel Joints: Conceal joints behind rustication joints, unless approved by Engineer in writing.
- D. 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.
- E. Pan Forms: Not Used
- F. 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.
- G. 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.
- H. Controlled Permeability Formwork (CPF) Liner: Not Used.
- I. 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 biodegradable. 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

### 3.01 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.

### 3.02 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.
- F. 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.

G. 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.

H. 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.

I. 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.

J. Joints:

1. For joint treatment, comply with Section 03251, Concrete Accessories. Locate joints as shown and specified.

K. 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.

L. 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.

M. 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.

N. Tie Hole Repair:

1. Repair tie holes in accordance with Section 03300, Cast-In-Place Concrete.

### 3.03 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.

### 3.04 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.

### 3.05 CONTROLLED PERMEABILITY FORMING LINER

- A. Where shown or indicated in the Contract Documents, install controlled permeability forming (CPF) liner material in accordance with manufacturer's instructions so that liner entirely and continuously covers forming surface.
- B. Do not use form release agent on forms with CPF liner. Remove residual traces of release agent on previously used forms prior to placing liner.
- C. Joints and seams in CPF liner shall be taped with materials recommended by liner manufacturer. Attach CPF liner to form surface at intermediate spacing to prevent buckles and ripples in liner material when warmed by fresh concrete placement. Spacing of attachments shall not exceed two feet.
- D. Form panel edges, except the bottom, shall be taped around corner with materials recommended by liner manufacturer. Edges of penetrations through form, including form tie holes, shall be taped or otherwise sealed. Leave open the liner at bottom edge of forms to facilitate drainage.
- E. CPF liner can be reused one time without removing liner from forms. Prior to reuse, wash the liner material and remove all concrete and other foreign material.

### 3.06 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.

### 3.07 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.

### 3.08 REMOVAL OF FORMS

- A. Determination of time between placing concrete and removing forms and shoring is Contractor's responsibility. 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:

<b>TABLE 03100-A, REMOVAL OF FORMS</b>					
<b>Component</b>	<b>Average Daily Ambient Air Temperature (deg F)</b>				<b>Min. Concrete Compressive Strength for Form Removal</b>
	<b>Over 70 F</b>	<b>60 F to 70 F</b>	<b>50 F to 60 F</b>	<b>Below 50 F</b>	
Walls	One day	Two days	Three days	See Paragraph 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:

## 03100 - CONCRETE FORMING

- 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.

### 3.09 PERMANENT SHORES

- A. Provide permanent shores in accordance with ACI 301 and ACI 350.5.
- B. Reshores are not allowed.

### 3.10 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.

END OF SECTION 013100

03100 - CONCRETE FORMING

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## PART 1 – GENERAL

### 1.01 - SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment and incidentals as shown, specified and required to furnish and place steel reinforcement for concrete including all cutting, bending, fastening and any special work necessary to hold the reinforcement in place and protect it from injury and corrosion.
- B. The work shall also include furnishing deformed reinforcing bars to be grouted into reinforced concrete masonry walls.

### 1.02 - RELATED SECTIONS

- A. Section 03300, Cast-in-Place Concrete.

### 1.03 - SUBMITTALS

- A. The Contractor shall submit submittals in accordance with Section 01300.
- B. Submit for approval the following shop drawings:
  - 1. Detailed placing and shop fabricating drawings, prepared in accordance with ACI 315 shall be furnished for all concrete reinforcement. These drawings shall be made to such a scale as to clearly show construction joint locations, openings, the arrangement, spacing and splicing of the bars. No materials shall be cut or fabricated until related drawings have been approved by the Engineer.
  - 2. Mill test certificates

## PART 2 – PRODUCTS

### 2.01 - GENERAL

- A. Materials:
  - 1. Reinforcing bars shall be deformed new billet steel bars conforming to ASTM A 615, Grade 60.
- B. Bars noted on the plans to be epoxy-coated, shall be coated with Scotch-kote Brand Fusion Bonded Epoxy Coating 213 or 214 as manufactured by St. Paul, Minnesota, or equal. Coating shall be applied to cleaned steel reinforcing bars by the electrostatic spray method and fully cured

in accordance with the recommendations of the manufacturer of the coating material. Before coating, the bars shall be cleaned by abrasive blast cleaning to meet the requirements of near white metal in accordance with SSPC-SP10. The coating shall be applied to the cleaned surface as soon as possible after cleaning, and before oxidation of the surface discernible to the unaided eye occurs. However, in no case shall application of the coating be delayed more than 8 hours after cleaning. The film thickness of the coating after curing shall be 5 to 20 mils, inclusive, as measured using ASTM G 12 on the body of the reinforcing bar between the deformations and/or ribs on a straight length of bar. The coating shall be free from holes, voids, cracks, and damaged areas discernible to the unaided eye. Damaged or other unsatisfactory areas shall be patched with a coating material and by a method recommended by the coating manufacturer. Epoxy coated reinforcing bars shall conform to ASTM A 775.

- C. Wire mesh reinforced shall conform to ASTM A1064 "Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete."
- D. Steel wire shall conform to ASTM A1064 plain, cold-drawn steel.
- E. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting, fastening reinforcing bars and welded wire fabric in placed. Use wire bar type supports complying with CRSI recommendations, unless otherwise acceptable.
  - 1. For slabs-on-grade, use supports with stand plates or horizontal runners where base material will not support chair legs.
  - 2. For exposed-to-view concrete surfaces, where legs supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class 10 or stainless steel (CRSI, Class 11).
- F. Tie wires for reinforcing steel shall be 16 gauge or heavier, black annealed wire.
- G. Satisfactory test certificates shall be furnished Engineer on any shipments as required.
- H. All reinforcing steel must be made in the USA

### PART 3 - EXECUTION

#### 3.01 - FABRICATION AND STORAGE

- A. All reinforcement shall be cut and bent cold accurately to the dimensions approved. Bends shall be made in conformance with the Manual of Standard Practice of the Concrete Reinforcing Steel

Institute. If shipped to the job fabricated, it shall be properly bundled and tagged so that it can be handled without damage and readily identified with the approved placing diagrams.

- B. Reinforcing steel shall be stored above ground on platforms or other supports and shall be protected from the weather at all times by suitable covering. It shall be stored in an orderly manner and plainly marked to facilitate identification.

### 3.02 - CLEANING AND PLACING

- A. Before being placed in position, the reinforcement shall be thoroughly cleaned of all loose mill scale and rust, and of any dirt, coatings, or other material that might reduce the bond.
- B. All reinforcement shall be placed in the exact positions and with the spacing shown on the drawings, or as otherwise directed. It shall be so securely fastened in position by saddle tying at intersections with annealed wire of not less than No. 16 gauge or by suitable clips that no displacement will occur. Precast concrete blocks or metal chairs as approved by the Engineer shall be used for supporting horizontal reinforcement in slabs on grade, and footings. For all concrete surfaces, where legs of supports are in contact with forms, provide supports complying with CRSI "Manual of Standard Practices" as follows: Provide either, plastic coated or stainless steel legs, No reinforcement shall be placed so that there is less concrete between it and the finished concrete surface than the minimum shown on the drawings, or specified in the ACI –318 and 350R Building Code.
- C. Wire mesh reinforcement shall be securely fastened at the ends and edges. Wire mesh shall be supported at elevations indicated prior to concrete placement. Edge laps shall not be less than one mesh in width and end laps not less than two meshes in length.
- D. Substitutions of different size bars or mesh will be permitted only with the written authorization of the Engineer.
- E. Concrete shall not be placed until the reinforcing steel is inspected and permission for placing concrete is granted by Engineer. All concrete placed in violation of this provision will be rejected.

END OF SECTION 03210

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## PART 1 – GENERAL

### 1.01 DESCRIPTION

- A. Scope:
  - 1. CONTRACTOR shall provide 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.

### 1.02 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.

### 1.03 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.
    - 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.

### 1.04 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 01610, Transportation and Handling of Materials and Equipment.
- 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 01610, Transportation and Handling of Materials and Equipment.

PART 2 – PRODUCTS

2.01 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 flat strip 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.

2.02 PREFORMED EXPANSION JOINT FILLER

- A. Provide preformed expansion joint filler complying with ASTM D1752, Type I (sponge rubber) or Type II (cork).

2.03 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.

## 2.04 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.

## 2.05 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 Armatex 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.

## 2.06 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

### 3.01 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.

### 3.02 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.

3.03 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.

3.04 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.
- 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.

### 3.05 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.

### 3.06 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 joined 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.

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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 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.

### 3.07 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.

### 3.08 BEARING PAD INSTALLATION

- A. Neoprene Bearing Pad: Install with water insensitive adhesive in accordance with manufacturer's instructions.

END OF SECTION 03251

PART 1 – GENERAL

1.01 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 ACI350.5 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.

1.02 REFERENCES

- A. Standards referenced in this Section are:
  - 1. AASHTO M 182, 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 Concrete 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.

### 1.03 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. 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.
- F. 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).

#### 1.04 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.
    - b. Colored Cement Pigment Color Samples: Submit complete selection of manufacturer's standard and custom colors for final selection by ENGINEER.
  - 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.

#### 1.05 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

### 2.01 GENERAL

- A. Not used.

### 2.02 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 (SO<sub>3</sub>) 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.

### 2.03 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.

## 2.04 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.

## 2.05 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:
- 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:
- 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.
  - Product and Manufacturer: Provide one of the following:
    - DCI or DCI-S, by Grace Construction Products.
    - Rheocrete CNI, by Master Builders, Inc.
    - Eucon CIA, by Euclid Chemical Company.
    - Or equal.
  - Adjust quantity of mix water to account for water portion of calcium nitrite solution.
  - Provide retarding admixtures as required, if set time is accelerated.

## 2.06 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 <sup>(1)</sup>		Minimum	Max. W/CM <sup>(4)</sup>	Slump <sup>(2)</sup>	Air <sup>(6)</sup> (%)	Min. Comp Strength <sup>(3)</sup> (psi)
	Size A	Size B	Cementitious <sup>(5)</sup> (lbs/cu yd)				
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:

- 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.
- Slumps indicated are prior to addition of high range water reducing admixture or plasticizing admixture.
- 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. Lightweight Concrete: Not used.
- C. 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.
- D. 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.
- E. 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.
- F. 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.

## 2.07 BONDING AGENT

- A. Provide epoxy and epoxy-cement bonding agents in accordance with Section 03251, Concrete Accessories.

## 2.08 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.

## 2.09 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.
  - 3) 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 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

### 3.01 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.

### 3.02 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.

3.03 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.

### 3.04 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.

### 3.05 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.

### 3.06 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, damp proofing, 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.
- C. 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.
- D. 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.
- E. 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.

### 3.07 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 drip- ping, 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.

### 3.08 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.

3.09 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. 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.
- B. 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.
- C. 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.
- D. Concrete Tolerance Verification Measurements: Refer to Article 3.9 of this Section.
- E. 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.

END OF SECTION 03300



## 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 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**

<b>Application</b>	<b>Required Grout Material Type</b>
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

<b>Application</b>	<b>Required Grout Material Type</b>
Grout for setting filter underdrain blocks, and for filling voids between filter underdrain blocks, and for filling voids between filter underdrain blocks and walls	Filter Underdrain Blocks Grout
Applications not listed above, where grout is indicated on the Drawings	Class I Non-Shrink, unless shown or indicated otherwise

## 1.02 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 Surfacing, and Polymer Concretes.
7. ASTM C579, Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, 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, Test 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.

## 1.03 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.

#### 1.04 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.

## 1.05 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

### 2.01 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.

### 2.02 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.

## 2.03 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 minus one inch).

D. Filter Underdrain Blocks Grout:

1. Grout shall comply with Article 2.1 of this Section. Grout shall consist of one part cement to two parts sand with shrinkage-reducing admixture. Class I or Class II non-shrink grout may be used in lieu of filter underdrain blocks grout.
  - a. Minimum Compressive Strength: 4,000 psi at 28 days.
  - b. Maximum Water-Cement Ratio: 0.45 by weight.

2.04 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

3.01 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.

3.02 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.

### 3.03 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.
    - d. 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 03600



## PART 1 – GENERAL

### 1.01 - SECTION INCLUDES

- A. Repair of cracked, spalled, calcinated and hollow areas on concrete tank interior floors and walls.

### 1.02 - SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Submit manufacturers' product data and application requirements for proposed materials used to repair spalls and cracks.
- C. Submit documentation on characteristics of proposed media for abrasive blasting.
- D. Submit documentation indicating product applicators are trained and approved by product manufacturer.

### 1.03 - REGULATORY REQUIREMENTS

- A. Coatings shall comply with NYCRR, Part 205, of the New York State Department of Environmental Conservation (NYSDEC).
- B. Transport debris and rubbish in accordance with New York State Department of Environmental Conservation Law, Article 27, Treatment and Disposal of Refuse and Other Solid Waste.

### 1.04 - EXISTING CONDITIONS

- A. Allow Owner to conduct an inspection after tank cleaning to identify areas for repair.

## PART 2 – PRODUCTS

### 2.01 MATERIALS

- A. A cementitious epoxy resin compensated 3-component, solvent free, coating material with corrosion inhibitor, used as bonding primer and reinforcement corrosion protection. Cementitious epoxy shall be Sika Armatec-110 Epocem or approved equal.
- B. A two-component, polymer-modified, Portland cement based, fast-setting, trowel-grade mortar. It is a high-performance repair mortar for horizontal surfaces offer the additional benefit of Sika FerroGard 901, a penetrating corrosion inhibitor. This mortar shall be Sikatop-122 Plus or approved equal.
- C. A two-component, polymer-modified, Portland cement based, fast-setting, trowel-grade mortar. It is a high-performance repair mortar for vertical surfaces offer the additional benefit of Sika FerroGard 901, a penetrating corrosion inhibitor. This mortar shall be Sikatop-123 Plus or approved equal.
- D. Flexible crack sealant, a hydrophobic polyurethane that is designed to corm flexible gaskets of plug joints and cracks in concrete for water infiltration. The crack sealant shall be WikaFix HH LV or approved equal.
- E. Water: Potable, clean and free from oils, acids, alkali organic matter and other deleterious material.

## PART 3 - EXECUTION

### 3.01 - PROTECTION

- A. Protect pipe openings so that no materials enter into the lines during preparation and repair.

### 3.02 - SURFACE PREPARTION

- A. Interior Abrasive blasting: Utilize abrasive blasting to remove all existing coatings and deposits at the area to be repaired. Remove loose material to sound substrate. Equipment shall have ample capacity to furnish the required volume of compressed air to operate the blast effectively. The air shall be free of oil or moisture. Media shall be composed principally of silica grains. Do not utilize previously used media for abrasive blasting. Conduct abrasive blasting to prevent spread of media to adjoining property.
- B. Surfaces to be repaired and coated shall be clean.
- C. Mechanical chipping: Where necessary, and as directed by the Engineer, use chipping hammers to remove unsound concrete.

### 3.03 - REPAIR/RESTORATION

- A. Prepare surface in accordance with manufacturers recommendations. Surface must be clean and sound, Remove all deteriorated concrete, dirt, oil, grease, and other bond-inhibiting materials from the area to be repaired. Repair area should not be less than 18" in depth.
- B. Preparation work should be done by high pressure water blast, cscabber or other appropriate mechanical means to obtain an exposed aggregate surface profile of +/- 1/16 ".
- C. Saw cu edges to a dovetail configuration is recommended.
- D. Substrate should be Saturated Surface Dry (SSD) with clean water prior to application. No standing water should remain during application.
- E. Steel reinforcement should be thoroughly prepared by mechanical cleaning to remove all traces of rust. For priming of reinforcement steel apply Sika Armatec 110 EpoCem or approved equal.
- F. Prime concrete substrate surfaces with a brush or sprayed applied coat of Sika Armatec 110 EpoCem of approved equal.
- G. The repair mortar must be applied to the wet scrub coat before it dries.

### 3.04 - CLEANUP

- A. Maintain work area in a neat, orderly fashion. Debris such as used sand, muck, rust, scale, shall be frequently cleaned up and removed from the site. Thinners used to clean spray guns and other tools and equipment shall be held in containers and removed from the site to an approved disposal area by the Contractor. Do not clean equipment in tank.
- B. After completion of repair, thoroughly clean tank interior. Sweep broom clean.

03930 – CONCRETE REHABILITATION

- C. Upon completion of the work, remove all excess material, rigging, empty containers, and supplies, from the site. Buildings and grounds shall be left in as good condition as when work was started.
- D. Transport debris and rubbish in accordance with New York State Department of Environmental Conservation Law, Article 27, Treatment and Disposal of Refuse and Other Solid Waste.

END OF SECTION 03930

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PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.02 RELATED SECTIONS

- A. Section 05120 - Structural Steel Framing

1.03 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. 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 2020 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 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

#### 1.04 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.

#### 1.05 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

### 2.01 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.

### 2.02 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 2020 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.

### 2.03 STAINLESS STEEL BOLTS

- A. Stainless steel bolts shall conform to ASTM F593. 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.

### 2.04 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 "DEWALTtud SD-1" or "DEWALTtud SD-2" by DEWALT 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 DEWALT 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 DEWALT 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 DEWALT 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 "DEWALT 1000+" by DEWALT 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 DEWALT 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 DEWALT 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-200 Max" by Hilti, Inc., "SET Epoxy Tie" or "AT" by Simpson Strong-Tie Co., or "DEWALT AC 100+ Gold" or "T308+ Epoxy" by DEWALT 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.

## 2.05 MASONRY ANCHORS

- A. Anchors for fastening to solid or grout-filled masonry shall be adhesive anchors as specified above for concrete anchors.

## 05050 - METAL FASTENING

- 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 DEWALT 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.

### 2.06 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.

### 2.07 WELDED STUD CONNECTORS

- A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

### 2.08 EYEBOLTS

- A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

### 2.09 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

### 3.01 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.

## 05050 - METAL FASTENING

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.

## 3.03 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.

## 3.04 INSPECTION

- A. High strength bolting will be visually inspected in accordance with AISC 348 "The 2020 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.

## 3.05 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 05050

PART 1 - GENERAL

1.01 - RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 - SUMMARY

- A. Section Includes:
  - 1. Structural steel.
  - 2. Grout.
  - 3. Baseplates

1.03 - DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
- C. Heavy Sections: Rolled and built-up sections as follows:
  - 1. Shapes included in ASTM A6 with flanges thicker than 1-1/2 inches.
  - 2. Welded built-up members with plates thicker than 2 inches.
  - 3. Column base plates thicker than 2 inches.

1.04 - PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering design by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated. Where beam end reactions are not shown on drawings, designer shall design shear connection to resist the reaction resulting from the maximum allowable uniform load of the beam found in AISC specification being applied along its full length.

1. Select and complete connections using AISC 360.
  2. Use ASD; data are given at service-load level.
- B. Moment Connections: Type FR, fully restrained. Provide design and details of moment connections to resist forces shown in the contract drawings.
- C. Construction: Moment frame.

#### 1.05 - SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
1. Shop drawings and required calculations shall bear the seal and signature of a registered professional engineer licensed in the state in which the project is located. Structural steel shop drawings will not be reviewed without said seal and signature.
    - a. A full set of Engineering Calculations for all beam-to-column moment connections shall be submitted to the engineer of record for approval. The steel fabricators drawings shall not be reviewed without said engineering calculations affixed with a seal and signature of licensed New York state professional engineer.
  2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  3. Include embedment drawings.
  4. Indicate profiles, sizes, spacing, and locations of structural members, openings, attachments, fasteners, connections, cambers, holes and other pertinent data. Include locations of structural members, openings, attachments and loads.
  5. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
  6. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.
  7. For structural-steel connections indicated to comply with design loads, include structural design data signed and sealed by the qualified professional engineer responsible for their

preparation.

- C. Qualification Data: For qualified Installer / fabricator.
- D. Welding certificates. Submit certificates certifying that welders employed on the work have met AWS qualifications within the previous 12 months.
- E. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- F. Mill test reports for structural steel, including chemical and physical properties. Indicate structural strength, destructive and non-destructive test analysis.
- G. Product Test Reports: For the following:
  - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
  - 2. Direct-tension indicators.
  - 3. Tension-control, high-strength bolt-nut-washer assemblies.
  - 4. Shear stud connectors.
  - 5. Shop primers.
  - 6. Non-shrink grout.
  - 7. Insert product.

#### 1.06 - QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD. Fabricator shall have a minimum of 5 (five) years documented experience with performing the work of this section.
- B. Installer Qualifications: A qualified installer specializing in performing the work of this section with a minimum of 3 (three) years documented experience.
- C. Delegated Connection Designer: Connection not fully detailed on the contract drawings shall be designed under direct supervision of a professional structural engineer experienced in design of this work and licensed in the state in which the project is located. The shop drawings shall bear the seal and signature of said professional structural engineer.

- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."
- E. Comply with applicable provisions of the following specifications and documents:
  - 1. AISC Code of Standard Practice for Steel Buildings and Bridges. .
  - 2. AISC Specification for the design, fabrication, and erection of Structural Steel for Buildings.
  - 3. AISC 360.
  - 4. RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."

#### 1.07 - DELIVERY, STORAGE, AND HANDLING

- A. Deliver, Store and Handle products to the site under provision of division 1 specification of this project manual.
- B. Schedule deliveries of materials to the site at intervals which will ensure uninterrupted progress of the work.
- C. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
  - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- D. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
  - 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
  - 2. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
  - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F1852 fasteners and for retesting fasteners after lubrication.

#### 1.08 - COORDINATION

- A. Coordinate the work under Division 1 specification of this project manual.



- B. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
- C. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.
- D. Coordinate the work of this section with utilities installation and all other adjacent work.
- E. Coordinate the work of this section such that general progress of the work is not interrupted.

## PART 2 - PRODUCTS

### 2.01 - STRUCTURAL-STEEL MATERIALS

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 50 percent.
- B. W-Shapes: ASTM A992.
- C. Channels, Angles, S-Shapes: ASTM A36.
- D. Plate and Bar: ASTM A36.
- E. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B, structural tubing.
- F. Steel Pipe: ASTM A53, Type E or S, Grade B.
  - 1. Weight Class: As shown in contract documents..
- G. Welding Electrodes: Comply with AWS requirements.

### 2.02 - BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A490, Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436, Type 1, hardened carbon-steel washers with plain

finish.

1. Direct-Tension Indicators: ASTM F959, Type 490, compressible-washer type with plain finish.
- C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
1. Finish: Hot-dip zinc coating.
  2. Direct-Tension Indicators: ASTM F959, Type 325, compressible-washer type with mechanically deposited zinc coating finish.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
1. Finish: Plain.
- E. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- F. Unheaded Anchor Rods: ASTM F 1554, Grade 36. Weldable as indicated in the contract drawings.
1. Configuration: Straight or Hooked.
  2. Nuts: ASTM A563 heavy-hex carbon steel.
  3. Plate Washers: ASTM A36 carbon steel.
  4. Washers: ASTM F436, Type 1, hardened carbon steel.
  5. Finish: Hot-dip zinc coating, ASTM A153, Class C.
- G. Headed Anchor Rods: ASTM F1554, Grade 55, weldable, straight. As indicated in contract drawings.
1. Nuts: ASTM A 563 heavy-hex carbon steel.
  2. Plate Washers: ASTM A 36 carbon steel.

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3. Washers: ASTM F 436, Type 1, hardened carbon steel.
  4. Finish: Plain.
- H. Threaded Rods: ASTM A 36.
1. Nuts: ASTM A 563 heavy-hex carbon steel.
  2. Washers: ASTM F 436, Type 1, hardened carbon steel.
- I. Clevises: Made from cold-finished carbon steel bars, ASTM A108, Grade 1035.
- J. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1030.
- K. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1018.

### 2.03 - PRIMER

- A. Primer: Comply with Division 09 painting Sections.
- B. Galvanizing Repair Paint: ASTM A780.

### 2.04 - GROUT

- A. Non-metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and non-staining, mixed with water to consistency suitable for application and a 30-minute working time. Grout shall consist of a premixed compound with cement, water reducing and plasticizing additives capable of developing a minimum compressive strength of 7000 psi at 28 days.

### 2.05 - FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
1. Camber structural-steel members where indicated.
  2. Fabricate beams with rolling camber up.
  3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
  4. Mark and match-mark materials for field assembly.

5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
  6. Bearing surfaces shall be planned true to give full bearing over entire surface.
  7. Continuously seal joined members by intermittent welds and plastic filler. Grind welds smooth where exposed or where interference with other building materials is encountered.
  8. Splicing is not permitted unless indicated on the plans or accepted on the final shop drawings.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces. Mechanically thermal cut bolt holder shall not be permitted unless prior approval by Architect is given in writing.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning SSPC-SP 2, "Hand Tool Cleaning or SSPC-SP 3, "Power Tool Cleaning."
- F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Shop prime non-exposed steel members after fabrication in accordance with SSPC-PA. Do not prime surfaces that will be fireproofed, field welded or are in contact with concrete or high strength bolts.
- H. Paint exposed structural steel members in accordance with applicable Division 09 specifications.
- I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning. Unless approved by Architect in writing.
  2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to

steel surfaces.

3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

## 2.06 - SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  1. Joint Type: Snug tightened. Unless otherwise shown in contract drawings or required by connection designer.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

## 2.07 - SHOP PRIMING

- A. Shop prime steel surfaces except the following:
  1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  2. Surfaces to be field welded.
  3. Surfaces to be high-strength bolted with slip-critical connections.
  4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
  5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
  1. SSPC-SP 2, "Hand Tool Cleaning."
  2. SSPC-SP 3, "Power Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5

mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

## 2.08 - GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123.
  1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
  2. Galvanize lintels attached to structural-steel frame and located in exterior walls.

## 2.09 - SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
  1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents. Inspections and test will not relieve the contractor of responsibility for providing materials and fabrication and erection procedures in compliance with specified requirements. The contractor is to verify that all materials meet or exceed the requirements specified in these specifications. Contract documents and related references materials not in compliance with specified requirements will be rejected.
- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
  1. Liquid Penetrant Inspection: ASTM E 165.

2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
  3. Ultrasonic Inspection: ASTM E 164.
  4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
  2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

## PART 3 - EXECUTION

### 3.01 - EXAMINATION

- A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected. Beginning of installation means erector accepts existing conditions.

### 3.02 - PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.
  2. Clean bearing surfaces and other surfaces which will be in permanent contact.

### 3.03 - ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Proceed with installation only after unsatisfactory conditions have been corrected beginning of installation means erector accepts existing conditions.
- C. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
  - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Weld plate washers to top of baseplate.
  - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
  - 4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
  - 5. Coordinate placement of anchors in concrete or masonry construction for securing plates.
- D. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- E. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  - 1. Level and plumb individual members of structure.
  - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- F. Splice members only where indicated.
- G. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1.



- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- J. Erect all components in accordance with approved shop drawings after erection, prime welds, abrasions, and surfaces not shop primed or galvanized, as required, except surfaces to be in contact with concrete.
- K. Field weld components and shear studs as indicated on approved shop drawings and in accordance with AWS D1.1.

### 3.04 - FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Snug tightened unless specifically identified as pre-tensioned or slip critical in contract drawings or calculations by delegated connection designer.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  - 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
  - 2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
  - 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
  - 4. Connections and abrasions shall be cleaned, prepared and finished in the same manner and with the same materials used in shop finishing.

### 3.05 - FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to

inspect field welds and high-strength bolted connections.

- B. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
  - 1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
    - a. Liquid Penetrant Inspection: ASTM E 165.
    - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    - c. Ultrasonic Inspection: ASTM E 164.
    - d. Radiographic Inspection: ASTM E 94.
- D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:
  - 1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
  - 2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.
- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

### 3.06 - TOLERANCES

- A. All members shall be installed within AISC tolerances and the following:
  - 1. Maximum variation from Plumb: 1/4" (6mm) per story, non-cumulative.
  - 2. Maximum offset from true alignment: 1/4"

### 3.07 - REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair

galvanizing to comply with ASTM A780.

- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

- 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

- C. Touchup Painting: Cleaning and touchup painting are specified in Section 09910.

### 3.08 - ADJUSTING

- A. All misfits due to errors in locations or fabrication or inaccuracies in the setting of anchor bolts or other items of attachment or support shall be immediately reported to the Engineer and corrected in a manner subject to approval by the Engineer.
- B. Submit method of correction to the Engineer under Division 1 Specification provisions,
- C. Proceed with corrective work only after receiving written approval from the Engineer.
- D. All corrections shall be made at no additional cost to the Owner.

+ + END OF SECTION + +

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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 miscellaneous metal fabrications including surface preparation and shop priming.
  - 2. Providing openings in miscellaneous metal fabrications to accommodate the Work under this and other Sections, and attaching to miscellaneous metal fabrications all items such as sleeves, bands, studs, fasteners, 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 the Work to be installed with, or attached to miscellaneous metal fabrications Work.
  - 2. Hot-dip Galvanizing: Coordinate with steel fabricator detailing for and fabrication of assemblies to be hot-dip galvanized, to minimize distortion during galvanizing process.
- C. Related Sections:
  - 1. Section 03600, Grouting.
  - 2. Section 05050, Metal Fastening.

1.02 REFERENCES

- A. Standards referenced in this Section are:
  - 1. ANSI A14.3, Ladders – Fixed –Safety Requirements.
  - 2. ANSI Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.
  - 3. ASTM A36/A36M, Specification for Carbon Structural Steel.
  - 4. ASTM A53/A53M, Specification for Pipe Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 5. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 6. ASTM A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - 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 A384/A384M-02 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
  - 9. ASTM A500, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
  - 10. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
  - 11. ASTM A992/A992M, Specification for Structural Steel Shapes.
  - 12. ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  - 13. ASTM B211, Specification for Aluminum and Aluminum-Alloy Bar, Rod and Wire.
  - 14. ASTM B308/B308M, Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
  - 15. ASTM B429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
  - 16. ASTM B632/B632M, Specification for Aluminum-Alloy Rolled Tread Plate.
  - 17. AWS D1.1/D1.1M, Structural Welding Code – Steel.
  - 18. AWS D1.2/D1.2M, Structural Welding Code – Aluminum.
  - 19. AWS D1.6, Structural Welding Code – Stainless Steel.
  - 20. OSHA 29 CFR 1910, Occupational Health and Safety Standards.

21. ASTM A514/A514M, Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.

### 1.03 QUALITY ASSURANCE

- A. Qualifications:
  1. Welding:
    - a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, D1.2/D1.2M, or D1.6, as applicable.
    - b. When requested by ENGINEER, provide certification that each welder employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

### 1.04 SUBMITTALS

- A. Action Submittals: Submit the following:
  1. Shop Drawings:
    - a. Fabrication and erection details for assemblies of miscellaneous metal Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings and templates for locating and installing miscellaneous metal items and anchorage devices.
  2. Product Data:
    - a. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.
  3. Samples:
    - a. Sets of representative Samples of materials including nosings, rungs, and other finished products as requested by Engineer. Engineer's review will be for color, texture, style, and finish only. Compliance with other requirements is exclusive responsibility of Contractor.
- B. Informational Submittals: Submit the following:
  1. Test and Evaluation Reports:
    - a. Mill test report that indicate chemical and physical properties of each type of material, when requested by Engineer.
  2. Qualifications Statements:
    - a. Copies of welder's certifications, when requested by Engineer.

### 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 materials to be embedded in other construction in ample time to prevent delaying the Work.

## PART 2 – PRODUCTS

### 2.01 MATERIALS

- A. Steel:
  1. W-Shapes and WT-Shapes: ASTM A992/A992M.
  2. S-Shapes and Channels: ASTM A572/A572M, Grade 50.
  3. Hollow Structural Sections: ASTM A500, Grade B.
  4. Angles, Plates, Bars: ASTM A36/A36M, ASTM A514/A514M AR400.
  5. Steel Pipe: ASTM A53/A53M, Grade B.

## 05501 - MISCELLANEOUS METAL FABRICATION

- B. Aluminum:
  - 1. Aluminum Shapes: ASTM B308/B308M, Alloy 6061-T6, ASTM B 221, Alloy 6061-T6.
  - 2. Aluminum Tubes and Pipes: ASTM B429, Alloy 6061-T6.
  - 3. Aluminum Bars and Rod: ASTM B211, Alloy 6061-T6.
  - 4. Aluminum Plates: ASTM B209, Alloy 6061-T6.
- C. Stainless Steel:
  - 1. Plates and Sheets: ASTM A240/A240M, Type 304L or Type 316 stainless steel.
  - 2. Submerged or Intermittently Submerged: Type 316 stainless steel.
  - 3. Non-submerged: Type 304L stainless steel.
- D. Stainless Steel Fasteners and Fittings: ASTM A 320/A 320M, Type 304L or Type 316 Stainless Steel.
- E. Zinc-coated Hardware: ASTM A153/A153M.

### 2.02 MISCELLANEOUS METAL ITEMS

- A. Shop Assembly:
  - 1. Pre-assemble items in the shop to the greatest extent possible to minimize field-splicing and field-assembly of units at the Site. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Aluminum Ladders:
  - 1. Fabricate ladders for locations shown or indicated with dimensions, spacing, details, and anchorages as shown and specified. Comply with OSHA 29 CFR 1910 and ANSI A14.3, except as otherwise shown or specified.
    - a. Unless otherwise shown, provide 1.5-inch diameter continuous side rails, spaced at least 1.5 feet apart.
    - b. Provide extruded square rungs, spaced maximum of 12 inches on centers, with non-slip surface on top of each rung. Adhesive strips for non-slip surfaces are not acceptable.
  - 2. Fit rungs in centerline of side rails, plug weld, and grind smooth on outer rail faces.
  - 3. Support each ladder at top and bottom and at intermediate points spaced not more than five feet on centers.
  - 4. Use welded or bolted brackets, designed for adequate support and anchorage, and to hold ladder clear of wall surface with minimum of seven inches between wall and centerline of rungs.
  - 5. Unless otherwise shown or approved by Engineer, extend rails 3.5 feet above top rung, and return rails to wall or structure, unless other secure handholds are provided. If adjacent structure does not extend above top rung, goose-neck extended rails back to structure to provide secure ladder access.
  - 6. Use extruded aluminum conforming to alloy and temper 6061-T6.
- C. Steel Lintels:
  - 1. Provide loose structural steel lintels for openings and recesses in masonry walls and brick walls as specified or as shown.
  - 2. Weld adjoining members together to form a single unit, where shown or indicated.
  - 3. Provide not less than eight inches bearing at each side of openings, unless otherwise shown.
  - 4. Steel lintels to be installed in exterior walls shall be hot-dip galvanized and finish painted. Other steel lintels shall be painted.
  - 5. Surface preparation and painting shall conform to Section 09900, Painting.

6. Where lintels are not shown on the Drawings, provide lintels as specified in the following table. Provide other lintels where shown and of size indicated on the Drawings.

D. Aluminum Stair Nosings:

1. Manufacturers: Provide products of one of the following:
  - a. Supergrit Type 241BF by Wooster Products, Inc.
  - b. Or equal.
2. Fabricate extruded aluminum nosing of sizes and configurations as shown on the Drawings.
  - a. Unless otherwise shown, provide ribbed abrasive filled type, using black abrasive filler.

Clear Span (Max)	Exterior Angle	Interior Angles (typical 8-inch wall)
4.0 feet	3.5 inches by 3.5 inches by 5/16 inches	Two 3.5 inches by 3.5 inches by 5/16 inches
6.0 feet	Four inches by 3.5-inches by 5/16 inches	Two 4 inches by 3.5 inches by 5/16 inches
8.0 feet	Five inches by 3.5 inches by 5/16 inches	Two 5 inches by 3.5 inches by 5/16 inches

3. Provide anchors for embedding in concrete, either integral or applied to treads, as standard with manufacturer.

E. Safety Post:

1. Provide safety post for each fixed access ladder located below an access hatch. Safety post shall be manufactured of high-strength structural material with telescoping tubular section that locks automatically when fully extended.
2. Products and Manufacturers: Provide products of one of the following:
  - a. LadderUP Safety Post by Bilco Company
  - b. Or equal.
3. Use upward and downward movement of post shall be controlled by stainless steel spring balancing mechanism.
4. Safety post shall be hot-dip galvanized steel.

F. Manhole Steps:

1. Provide manhole steps as shown on the Drawings. Conform to requirements of 29 CFR 1910 and ANSI A14.3.
2. Products and Manufacturers: Provide one of the following:
  - a. R-1982-W, manufactured by Neenah Foundry Company.
  - b. Or equal.
3. Vertical separation of steps shall be uniform at maximum of 12 inches on centers. Steps shall project evenly from manhole or chamber walls.
4. Material: Extruded aluminum.

G. Weir Plates:

1. Provide weir plates as shown on the Drawings. Use 3/8-inch aluminum.
2. Aluminum plate shall conform to alloy and temper 6061-T6.
3. Provided slotted holes for fasteners to allow weir plate to be leveled.
4. Fastening devices shall be Type 316 stainless steel in accordance with Section 05051, Anchor Systems.

H. Bollards:



## 05501 - MISCELLANEOUS METAL FABRICATION

1. Provide Schedule 80 galvanized steel pipe filled with concrete as shown on the Drawings. Paint as required in accordance with Section 09900, Painting. Unless otherwise shown or specified, finish-paint bollard "Safety Yellow."
- I. Miscellaneous Framing and Supports:
  1. Provide miscellaneous metal framing and supports that are not part of structural steel framework and are required to complete the Work.
  2. Fabricate miscellaneous units to sizes, shapes, and profiles shown on the Drawings or, if not shown, of required dimensions to receive adjacent grating, plates, tanks, doors, and other work to be retained by the framing.
  3. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all-welded construction using mitered corners, welded brackets, and splice plates and minimum number of joints for field connection.
  4. Cut, drill, and tap units to receive hardware and similar items to be anchored to the Work.
  5. Furnish units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units are to be installed after concrete is placed.
    - a. Except as otherwise shown, space anchors, 2.0 feet on centers, and provide units the equivalent of 1.25-inch by 1/4-inch by eight-inch strips.
    - b. Galvanize exterior miscellaneous frames and supports.
    - c. Where shown or indicated, galvanize miscellaneous frames and supports that are not to be installed outdoors.
  6. Miscellaneous steel framing and supports shall be hot-dip galvanized and finish-painted, unless otherwise shown or indicated.
- J. Aluminum Raised-pattern Floor Plate:
  1. Provide raised-pattern floor plate conforming to ASTM B632/B632M and manufacturer's standards. Provide plates of thicknesses shown.
  2. Products and Manufacturers: Provide products of one of the following:
    - a. 4-Way Safety Aluminum Plate, by Ryerson Tull Company.
    - b. Raised Pattern Floor Aluminum Plate, by Central Steel and Wire Company.
    - c. Or equal.
  3. Provide removable plates at locations and sizes shown. Provide perforated plates where shown.
  4. Provide each plate section with four lifting handles as recommended by manufacturer. Lifting handles shall be recessed, drop handle type. Maximum weight of checkered plate or plank section shall be 150 pounds.
  5. Finish: Anodized. Protect finish with factory-applied coating of manufacturer's standard lacquer coating, suitable for service on floor.
- K. Fasteners and Hardware: Provide Type 316 stainless steel fasteners for aluminum fabrications and zinc-coated hardware for galvanized fabrications, unless otherwise shown or specified.
- L. Anchors and Expansion Anchors: Refer to Section 05051, Anchor Systems.

### 2.03 FINISHING

- A. Surface Preparation and Shop Priming: Perform surface preparation and apply primer coat to miscellaneous metal fabrications in the shop.
- B. Galvanizing:
  1. Galvanizing of fabricated steel items shall comply with ASTM A123/A123M.
  2. Details of fabrication of steel items and assemblies to be hot-dip galvanized shall conform to recommendations of ASTM A384/A384M to minimize the potential for distortion.

## 05501 - MISCELLANEOUS METAL FABRICATION

- C. Aluminum Finish: Provide natural mill finish for aluminum Work unless otherwise shown or specified.

### 2.04 SOURCE QUALITY CONTROL

- A. Tests and Inspections:

- 1. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures complying with the Contract Documents.

## PART 3 – EXECUTION

### 3.01 EXAMINATION

- A. Examine conditions under which the Work is to be performed 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 are corrected.

### 3.02 INSTALLATION

- A. Install miscellaneous metal fabrications accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry, or other construction.
- B. Anchor securely as shown and as required for the intended use, using concealed anchors where possible.
- C. Fit exposed connections accurately together to form tight, hairline joints. Field- weld steel connections that are not to be exposed joints and cannot be shop- welded because of shipping size limitations. Comply with AWS D1.1/D1.1M, D1.2/D1.2M and D1.6, as applicable to the material being welded. Grind steel joints smooth and touch-up shop paint coat. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- D. Protection of Aluminum from Dissimilar Materials:
  - 1. Coat surfaces of aluminum that will contact dissimilar materials such as concrete, masonry, and steel.

END OF SECTION 05501

## PART 1 - GENERAL

### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.02 SUMMARY

- A. Section Includes:
  - 1. Pre-assembled modular aluminum cross-over stairs with nylon treads.
  - 2. Integral aluminum railings attached to metal 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.
  - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
  - 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, 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. applied in any direction.
    - b. Concentrated load of 200 lbf 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 applied horizontally on an area of 1 sq. ft..
- 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 1.5.

### 1.04 ACTION SUBMITTALS

- A. Product Data: For metal stairs and the following:
  - 1. Nylon landing and stair treads.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.

## 05510 - METAL STAIRS

### 1.06 Product Test Reports:

- A. Based on evaluation of comprehensive tests performed by a qualified testing agency for stairs and railings.

### 1.07 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.

### 1.08 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 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.
- 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 unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

## 05510 - METAL STAIRS

- 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.

### 2.03 ALUMINUM ACCESS STAIRS AND RAILINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Kee Safety
  - 2. Safety Rail Source
  - 3. Approved Equal.

### 2.04 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.

## PART 3 - EXECUTION

### 3.01 INSTALLATION, GENERAL

- A. 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.
- B. 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.

### 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.

## 05510 - METAL STAIRS

- 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, non-shrink grout unless otherwise indicated.
  - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

END OF SECTION 05510

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Aluminum stair with frame of structural sections, open risers, toeplates, aluminum grate treads, and non-slip nosings.
- B. Integral balusters and handrails.

1.02 RELATED SECTIONS

- A. 05523 - Pipe and Tube Railings.

1.03 REFERENCES

- A. Aluminum Association – ASD-1 Aluminum Standards and Data.
- B. ICC A117.1 - Buildings and Facilities Providing Accessibility and Usability for Physically Handicapped People.
- C. AWS A2.4 – Standard Welding Symbols.
- D. AWS D1.2/D1.2M – Structural Welding Code – Aluminum.
- E. ASTM B26/B26M – Specification for Aluminum-Alloy Sand Castings.
- F. ASTM B221 – Specification for Aluminum-Alloy Bars, Rods, Wires, Shapes and Tubes.
- G. ASTM B483/B483M – Specification for Aluminum and Aluminum-Alloy Drawn Tubes for General Purposes Applications.
- H. ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.
- I. ASTM E894 – Standard Test Methods for Anchorage at Permanent Metal Railing Systems and Rails for Building.
- J. ASTM E935 – Standard Test Methods for Anchorage at Permanent Metal Railing Systems and Rails for Buildings.
- K. NFPA 101 – Life Safety Code.

1.04 DESIGN REQUIREMENTS

- A. Fabricate stair and railing assembly to meet all applicable codes.
- B. Conform to the following codes, regulations and requirements:
  - 1. New York State Building Code.
  - 2. Occupational Safety & Health Act of 1970 (OSHA) regulations.
- E. Stair assembly shall support 300 lb. concentrated load at any point and a uniform live load of 100 lb/sq. ft., non-simultaneously with deflection not to exceed 1/240 of span.

#### 1.05 SUBMITTALS

- A. Submit under provisions of Section 01300 - Submittals.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Shop drawings shall bear the seal and signature of a registered professional engineer licensed in the State of New York.
- C. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

#### 1.06 QUALIFICATIONS

- A. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Submit shop drawings prepared under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of New York. Shop drawings shall be affixed with signature and seal of a Professional Engineer licensed in the state of New York.
- B. Welders' Certificates: Submit under provisions of Section 01300 - Submittals, certifying welders employed on the work, verifying AWS qualification within the previous 12 months.

#### 1.07 FIELD MEASUREMENTS

- A. Verify actual locations of walls and other construction contiguous with gratings by field measurements before submission of shop drawings and fabrication.

#### 1.08 COORDINATION

- A. Coordinate installation of anchorages for gratings, grating frames, and supports. 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 MATERIALS

- A. Structure Sections and Plates: Aluminum 6061-T6 Alloy, tempered.
- B. Bolts, Nuts and Washers: Stainless steel, Type 304.
- C. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; consistent with design of stair structure.
- D. Welding Materials: AWS D1.2/D1.2M; type required for materials being welded.
- E. Treads: Aluminum grating tread with 1 1/4 by 1 1/4 leg standard corrugated 90 degree angle nosing with carrier plates attached as manufactured by McNichols Co. or approved equal. Treads shall be GAL-150 (Swage-Locked); 1 1/2 inch by 3/16 inch grating by McNichols Co. or approved equal.
  - 1. Tread size: 12 1/8 inch x length indicated on the drawings.
- F. Provide integral Toeplates as required by applicable building code limiting the riser openings to less than 4 inches.



- G. Welds, Welding Metal: Aluminum.
- H. Electrodes shall be suitable for the material, positions and other conditions of use as recommended by AWS or the manufacturer.

## 2.02 FABRICATION - GENERAL

- A. Fabricate stair assembly to be self supporting and independent of adjacent wall construction.
- B. Fit and shop assemble in largest practical sections, for delivery to site.
- C. Fabricate components with joints tightly fitted and secured.
- D. Continuously seal jointed pieces with continuous welds.
- E. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush and hairline. Ease exposed edges to small uniform radius.
- F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- G. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- H. Accurately form components required for anchorage of stairs, landings and railings to each other and to building structure.

## 2.03 FABRICATION

- A. Fabricate stair to meet design and OSHA requirements.
- B. Form stringers with channels minimum 12 inches deep. Reinforce tread underside with angles welded to stringers.

## 2.04 FINISHES

- A. Clean surfaces of corrosion, scale, grease and foreign matter prior to finishing.
- B. Clear anodize finish. Finish stair after fabrication.
- C. Coat areas of aluminum to be in contact with dissimilar metals and concrete with (2) coats of bitumastic paint.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work. Verify dimensions and clearances of piping, conduit, structural elements adjacent to intended stair location prior to fabrication.
- B. Beginning of installation means erector accepts existing conditions.

## 05519 - ALUMNIUM METAL GRATING STAIRS

- C. Coordinate and supply items required to be embedded in masonry and concrete with setting templates, to appropriate contractor(s) for their installation. Provide information regarding the installation requirements accordingly.

### 3.02 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects to meet design requirements.
- B. Provide anchors, plates, angles, hangers and struts as required for connecting stairs to structure.
- C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Field weld components indicated on approved shop drawings. Perform field welding in accordance with AWS D1.1.
- E. Mechanically fasten joints butted tight, flush and hairline. Grind welds smooth and flush.
- F. Obtain Engineer approval prior to site cutting or making adjustments not indicated on the drawings nor on the approved shop drawing.
- G. After erection, prime welds, abrasions and surfaces not shop primed, except surfaces to be in contact with concrete.

### 3.03 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story.
- B. Maximum Offset From True Alignment: 1/8 inch.

END OF SECTION 05519

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Agreement, including General and Supplementary Conditions, and Division 1 Specifications apply to this Section.

### 1.02 SUMMARY

- A. This Section includes the following:
  - 1. Stair and Ramp Guardrails.
  - 2. Stair and Ramp Handrails.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Section 03300 – Cast-In-Place Concrete.
  - 2. Section 03600 – Grouting.
  - 3. Section 05501 – Metal Fabrications.

### 1.03 STANDARDS

- A. All Work of this Section shall conform to industry standards and/or manufacturer's recommendations.
- B. ASTM B247 – "Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings".
- C. ASTM B483/B483M – "Standard Specification for Aluminum and Aluminum Alloy Drawn Tube and Drawn Pipe for General Purpose Applications".
- D. AAMA 609 & 610 – "Cleaning and Maintenance Guide for Architecturally Finished Aluminum".
- E. AAMA 2604 – "Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels".

### 1.04 PERFORMANCE REQUIREMENTS

- A. All railings shall be supplied to conform to applicable sections of the following codes:
  - 1. New York State Building Code
  - 2. ADA Accessibility Guidelines (ADAAG)
- B. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
  - 1. Handrails:
    - a. Uniform load of 50 lbf/ft. applied in and direction.
    - b. Concentrated load of 2000 lbf. Applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
    - d. Top Rails of Guards:
      - 1) Uniform load of 50 lbf/ft. applied in any direction.
      - 2) Concentrated load of 200 lbf. Applied in any direction.
      - 3) Uniform and concentrated loads need not be assumed to act concurrently.
    - e. Infill Area of Guards:
      - 1) Horizontal concentrated load of 50 lbf. Applied to 1 sq. Ft. at any point in system, including panels, intermediate rails, balusters, or other

elements composing infill area. Load on infill area need not be assumed to act concurrently with loads on top rails.

- f. Deflection Limitation of Assembly: L/360 maximum between supports.
- C. Thermal Movements: Provide exterior railings 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 heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120°F, ambient; 180°F, material surfaces.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

#### 1.05 SUBMITTALS

- A. Pursuant to Section 01300 – Submittal Procedures.
- B. Pursuant to Section 01600 – Product Requirements.
- C. Design Data: Submit stamped structural calculations for connections designed by the Contractor. These calculations shall be prepared by a qualified licensed professional engineer registered in the State where the project is located. Include an insurance certificate of coverage naming the Project Owner as an additional insured.
- D. Product Data: For the following:
  - 1. Catalogue cuts/product data for railing and guardrail system.
  - 2. Manufacturer's product data for mechanically connected railings.
  - 3. Grout, fasteners, and paint products (as applicable).
- E. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer licensed in the State of the project, responsible for their preparation.
- F. Samples for Initial Selection: For products involving selection of color, texture, or design. Upon selection of color by Architect. Provide final samples in chosen color. Provide samples of different elements where the color may vary slightly based on the base material.
- G. Mill Certificates: Signed by manufacturers of aluminum products certifying that products furnished comply with requirements.
- H. Qualification Data: For professional engineer.
- I. Product Test Reports: Supplier shall submit calculations and test reports for complete system, including railing and infill panels. Calculations and test reports shall be stamped by a licensed PE, licensed in the State of the Project. Test report shall be in accordance with ASTM E935.

#### 1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 10 years documented experience producing aluminum railing and guardrail systems and capable of providing required professional engineering, stamped calculations, and stamped drawings.
- B. Source Limitations: Obtain each type of railing through one source from a single manufacturer.

## 1.07 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

## 1.08 COORDINATION AND SCHEDULING

- A. Coordinate installation of anchorages for railings. 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.
- B. Schedule installation so wall attachments are made only to completed walls. Do not support railing temporarily by any means that do not satisfy structural performance requirements.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Manufacturer: Superior Aluminum Products, Inc.; 555 E. Main St., PO Box 430, Russia, OH 45363. Phone: 937-526-4065. Fax: 937-526-3904. Email: [info@superioraluminum.com](mailto:info@superioraluminum.com). Web: [www.superioraluminum.com](http://www.superioraluminum.com). (Basis of Specification).
- B. Architect Approved Equivalent.

### 2.02 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

### 2.03 RAILING MATERIALS

- A. Rail, Post and Pickets: Aluminum extrusions; alloy and temper 6063-T4 or 6063-T6 for rail, posts, and pickets.
  - 1. Pipe: ASTM B483.
- B. Base Flanges, Anchors, and railing accessories: ASTM B247.
  - 1. Bases cast from manufacturer's standard A-356-T6, 535, or 713 aluminum alloys or solid extruded 6063 aluminum alloy stock.
  - 2. Base flanges and railing accessories cast from manufacturer's standard 319, A-356, A-356-T6, 535, or 713 aluminum alloys.
  - 3. Anchorages: Provide anchorage for fastening and complying with applicable Federal standards. All fasteners used in the system shall be aluminum or stainless steel.
- C. Fasteners: Provide anchorage for fastening and complying with applicable Federal standards. Fasteners used in the system shall be aluminum or stainless steel.
- D. Grout: See Section 03600 – Grouting.

## 2.04 HORIZONTAL GUARD RAIL AND HANDRAIL

- A. Horizontal Pipe Rail Guard Railing Series 500: 1-1/2 inch Schedule 40 Aluminum pipe with 1.9 inch outside diameter runs between posts and utilizes concealed fasteners. No joints shall be fastened via welding. Top rail shall be continuous through the full length of the system.
- B. Horizontal Pipe Rail:
  - 1. Pipe: 1-1/2 inch Schedule 40 Aluminum pipe with 1.9 inch outside diameter runs between posts and utilizes concealed fasteners.
  - 2. Top rail shall be continuous through the full length of the system.
- C. Round Posts:
  - 1. Post: 1-1/2 inch Schedule 40 Aluminum pipe with 1.9 inch outside diameter with reinforcement rebar inserts.
- D. Height:
  - 1. 42 inches unless otherwise noted.
- E. Component Parts:
  - 1. Provide all connecting components and fittings as required.
- F. Base: Size to fit the posts specified.
  - 1. Cover Flange for Embedded Posts.
- G. Hand Rail: Series 500 Mounted Hand Rail:
  - 1. Pipe: 1-1/2 inch Schedule 40 Aluminum pipe with 1.9 inch outside diameter.
  - 2. Handrail to run continuously throughout the whole length of handrail system.
  - 3. Mount to wall, guardrail system, or other structure by utilizing mounting plates.
  - 4. No components shall be fastened via welding.
  - 5. Handrail will be installed at a height as shown on Contract Drawings.
  - 6. Clearance of a minimum 1 1/2" shall exist between the wall or post surface and the handrail.
  - 7. Top and bottoms of handrail sections that stop at a landing, the handrail shall extend 12 inches horizontally beyond the top riser and 12 inches horizontally beyond the bottom tread.
  - 8. Handrail shall be continuous, without interruption by newel posts or other obstructions.
  - 9. Handrails shall return to a wall, guard or post as shown on the Contract Drawings.

## 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: 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 the same piece are not acceptable. Variations in other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings/guardrails.
- E. Painted Architectural Coating (AAMA 2604):

1. White.
  2. Black.
  3. Light Bronze.
  4. Dark Bronze.
  5. Sandstone.
  6. Almond.
  7. Tan.
  8. Custom colors as selected.
- F. Satin Anodized Finish:
1. 15 Minute: Architectural Clear Anodic Coating, AA-M12-C22-A21.
  2. 60 Minute: Architectural Class I, AA-M12-C21-A41.
  3. 60 Minute Brushed: Architectural Class I, AA-M35-C22-A41.
- G. Duranodic Architectural Hard Coat Anodized Finish, AA-M12-C22-A42.
1. Dark Bronze.
  2. Black.
  3. Custom colors as selected.

## 2.06 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Tolerances: Verify dimensions on site prior to shop fabrication for proper connection to building structure or substrate.
- C. Components or railing sections shall be fabricated to exact measurements specified through Drawings and field dimensions.
- D. Components or railing sections shall be fabricated at the manufacturing facility in largest practical site delivery sizes. 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.
- E. Pipe cuts shall be square and accurate for minimum joint-gap. Cuts shall be clean and free of chamfer, from deburring, nicks, and burrs.
- F. Connections: Fabricate railings and guardrails with welded connections unless otherwise indicated.
- G. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including all fittings.
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 flux immediately.
  4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- H. Railings angled horizontally, machine castings to proper angle.
- I. Fabricate railing system to meet step railing requirements, riser, and tread dimensions of the steps.

- J. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- K. Posts grouted in concrete to have one nominal ¼ inch nominal diameter weep hole, ½ inch nominal above post collar, in the plane of the rail.
- L. Provide inserts and other anchorage devices required for anchorage of framing. Fabricate anchorage devices capable of withstanding loads imposed by railings and/or guardrails. Fabricate anchors and related components of material and finish as required, or as specifically noted. Coordinate anchorage devices with supporting structure.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared. Fully review the supporting structure and substrate to verify a structurally sound base for anchoring railing system.
- 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. Ensure that adjacent surfaces, structures, and finishes are protected from damage by construction activities of this section.
- C. Use wood blocks and padding to prevent damage to railing members and fittings during erection.
- 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 components plumb and inline, accurately fitted, free of distortion or defects and securely anchored to building structure and/or substrate.
- C. Provide grounds, clips, backing materials, adhesives, brackets, anchors, and accessories necessary for a complete installation.
- D. Expansion Bolt Mounting: Anchor through base plates to concrete substrate.
- E. Sleeve Mounting:
  - 1. Arrange for casting of sleeves or core drill into concrete to provide holes for railing uprights.
  - 2. After setting, fill holes with hydraulic grout; brace members until grout is cured.
- F. Connect railing components in accordance with manufacturer's instructions applicable to the specified system. Tighten all fasteners so that completed railing is rigid and free of play at joints and component attachments.



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- G. Expansion Joints: Provide expansion joints for continuous spans in excess of 40 feet. Construct joints by deleting structural adhesive from one end of the spliced joint so that it is free to move in or out of the pipe. If a joint is provided every 30 feet, the width of the gap should allow 1/8 inch expansion for each 40°F of expected temperature rise.

### 3.04 ERECTION TOLERANCES

- A. Install railings plumb and level, securely fastened, with vertical members plumb.
  - 1. Maximum variation from plumb: ¼ inch.
  - 2. Maximum misalignment from true position: ¼ inch.
  - 3. Maximum misalignment between adjacent separated members: 1/8 inch.

### 3.05 CLEANING

- A. Remove temporary protective coverings immediately after erection if sunlight will damage coverings and finished product.
- B. Remove dust or other foreign matter from component surfaces; clean finishes in accordance with AAMA 609 and AAMA 610.

### 3.06 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 05523

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## PART 1 - GENERAL

### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.02 SUMMARY

- A. Section Includes:
  - 1. Metal bar gratings.
  - 2. Metal frames and supports for gratings.

### 1.03 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design gratings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
  - 1. Floors: Uniform load of 125 lbf/sq. ft. (6.00 kN/sq. m) or concentrated load of 2000 lbf (8.90 kN), whichever produces the greater stress.
  - 2. Floors: Uniform load of 250 lbf/sq. ft. (11.97 kN/sq. m) or concentrated load of 3000 lbf (13.40 kN), whichever produces the greater stress.
  - 3. Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft. (2.87 kN/sq. m).
  - 4. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft. (4.79 kN/sq. m).
  - 5. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of 250 lbf/sq. ft. (11.97 kN/sq. m) or concentrated load of 8000 lbf (35.60 kN), whichever produces the greater stress.
  - 6. Limit deflection to L/360 or 1/4 inch (6.4 mm), whichever is less.
- C. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.

### 1.04 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Pressure Locked Galvanized Metal Gratings.
  - 2. Clips and anchorage devices for gratings.
  - 3. Paint products.
- B. Shop Drawings: Include plans, sections, details, and attachments to other work.
- C. Delegated-Design Submittal: For installed products 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 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.
- B. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.

- C. Welding certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

#### 1.06 QUALITY ASSURANCE

- A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual" and NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- 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."

#### 1.07 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

#### 1.08 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 gratings, grating frames, and supports. 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 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 Bars for Bar Gratings: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A 1018/A 1018M.
- D. Wire Rod for Bar Grating Crossbars: ASTM A510/A510M.
- E. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, Grade 30 (Grade 205).
- F. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating.
- G. Expanded-Metal Carbon Steel: ASTM F1267, Class 1.
- H. Expanded-Metal Galvanized Steel: ASTM F1267, Class 2, Grade A.

## 2.02 FASTENERS

- A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F593 for bolts and ASTM F594 for nuts, Alloy Group 2 (A4).
- C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
  - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- 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, 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.

## 2.03 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is welded.
- B. Low-Emitting Materials: Paints and coatings 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."
- C. Shop Primers: Provide primers that comply with Section 09910 - Painting
- D. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- E. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.04 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling

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limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

- B. Cut, drill, and punch material 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.
- C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Welding: Comply with AWS recommendations and 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.
- F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
  - 1. Fabricate toeplates to fit grating units and weld to units in shop unless otherwise indicated.
  - 2. Fabricate toeplates for attaching in the field.
  - 3. Toeplate Height: 4 inches (100 mm) unless otherwise indicated.

### 2.05 METAL BAR GRATINGS

- 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. Barnett Bates Corporation.
  - 2. Borden Metal Products (Canada) Limited.
  - 3. IKG Industries; a division of Harsco Corporation.
  - 4. Ohio Gratings, Inc.
- B. Pressure-Locked Steel Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.
  - 1. Bearing Bar Spacing: 15/16 inch (24 mm) o.c.
  - 2. Bearing Bar Depth: As required to comply with structural performance requirements.
  - 3. Bearing Bar Thickness: As required to comply with structural performance requirements.
  - 4. Crossbar Spacing: 4 inches (102 mm) o.c.
  - 5. Grating Mark: As indicated.
  - 6. Traffic Surface: Serrated.
  - 7. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface.
- C. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
  - 1. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
  - 2. Provide no fewer than four saddle clips for each grating section composed of rectangular bearing bars 3/16 inch (4.8 mm) or less in thickness and spaced 15/16 inch (24 mm) or more o.c., with each clip designed and fabricated to fit over two bearing bars.

3. Provide no fewer than four weld lugs for each grating section composed of rectangular bearing bars 3/16 inch (4.8 mm) or less in thickness and spaced less than 15/16 inch (24 mm) o.c., with each lug shop welded to three or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
4. Provide no fewer than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
5. Furnish threaded bolts with nuts and washers for securing grating to supports.
6. Furnish self-drilling fasteners with washers for securing grating to supports.
7. Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.
  - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) Kee Industrial Products, Inc.; Grating Clip.
    - 2) Lindapter North America, Inc.; Grate-Fast.
- D. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
  1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
- E. Do not notch bearing bars at supports to maintain elevation.

## 2.06 GRATING FRAMES AND SUPPORTS

- A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
  1. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.
- B. Galvanize steel frames and supports in the following locations:
  1. Exterior.
  2. Interior, where indicated.
  3. Carrier angles for Galvanized Steel Grate treads and toeplates.

## 2.07 STEEL FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish gratings, frames, and supports after assembly.
- C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
  1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

## PART 3 - EXECUTION

### 3.01 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings 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 gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
- D. Fit exposed connections accurately together to form hairline joints.
  - 1. 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 the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- E. Attach toeplates to gratings by welding at locations indicated.
- F. Field Welding: Comply with the following requirements:
  - 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.
- G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

### 3.02 INSTALLING METAL BAR GRATINGS

- A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.
- C. Attach non-removable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

### 3.03 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 requirements for touching up shop-painted surfaces.
  - 1. Apply by brush or spray to provide a minimum 2.0-mil 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 099113 - EXTERIOR PAINTING and Section 099123 - INTERIOR PAINTING.



05530 - METAL GRATINGS

- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055305.11

05530 - METAL GRATINGS

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PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Glass fiber reinforced, resin fabrications.
- B. FRP guardrail and handrail systems.
- C. FRP gratings, support systems and connections.
- D. FRP ladders and Ladder Up Post.
- E. FRP stair stringers and connections.
- F. FRP stair treads.
- G. FRP toeplates.

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; 2018.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2019b.
- 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.

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.
- B. Railing systems shall be designed to withstand a single concentrated 200 pound point load applied in any direction at any point along the top rail in accordance with the Building Code of New York State.
- C. Molded grating and molded stair treads shall not deflect more than 1/4" and structural support members shall not deflect more than L/180 of span for structural members unless specifically stated otherwise in drawings and/or supplementary conditions. Connections shall be designed to transfer the design loads.
- D. 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.
- E. Design items with sufficient strength for handling stresses.

- F. The FRP standard railing system, including connections, shall be designed to meet the configuration and loading requirements of OSHA 1910.23 and IBC with a minimum 2.0 factor of safety.
- G. Additional ADA handrail to be installed where indicated on plans.
- H. The completed ladder installation shall meet the following load requirements set forth in OSHA 1910.27. The ladder shall also be capable of supporting a concentrated vertical load of 1,200 pounds applied at the mid-span of the rung. Manufacturer shall be required to provide supporting test data for rung capacity.
- I. All ladders shall be designed and laid out in strict accordance with OSHA 1910.27.
- J. Temperature exposure is limited to 100°F (38°C) unless specifically stated otherwise in drawings and/or supplementary conditions.
- K. Stair assembly Design:
  - 1. Uniform Load: 100 pounds per square foot
  - 2. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
- L. 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 300 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 SUBMITTALS

- A. See Section - 01300 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 shop drawings shall bear the seal and signature of a registered professional engineer licensed in the state of New York.

#### 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 the State in which the Project is located.

- B. The material covered by these specifications shall be furnished by an ISO-9001:2015 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 A/E, 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. Substitutions: See Section 01600 – Materials and Equipment.

#### 2.02 REGULATORY REQUIREMENTS

- A. Conform to UL (DIR) Assembly Design No. UL 94 V-0.
- B. Conform to applicable code for a flame/smoke index rating of 25 / 0 in accordance with UL (DIR) 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 E-84, 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 D638	psi	30,000	
Tensile Modulus	ASTM D638	psi	$2.5 \times 10^6$	
Flexural Strength	ASTM D790	psi	30,000	
Flexural Modulus	ASTM D790	psi	$1.8 \times 10^6$	
Flexural Modulus (Full Section)	ASTM D790	psi	$2.8 \times 10^6$	
Short Beam Shear (Transverse)	ASTM D2344	psi	4,500	
Shear Modulus (Transverse)	N/A	psi	$4.5 \times 10^5$	
Coefficient of Thermal Expansion	ASTM D696	in/in/deg F	$8.0 \times 10^{-6}$	
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 D635. (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 D635.

4. Food-grade with flammability characteristics of UL 94 V0 and the self-extinguishing requirements of ASTM D635.

<b>Resin Systems</b>	
<b>Description</b>	<b>Resin Base</b>
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" square mesh with a 2" depth with a tolerance of plus or minus 1/16" 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 316 stainless steel threaded rods for adjustability.
  - b. Pedestals shall be 2-1/8" x 3/16" 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". Grating pedestals are to be laid out according to the manufacturers published literature or as indicated in the contract drawings.
5. Provide 3" x 3" x 3/8" thick FRP ledge angles as required to mount grates to concrete surfaces. Provide 3/8" diameter 316SS Hilti Kwik Bolt TZ anchors stainless steel expansion type epoxy set anchors spaced at 16" 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 these 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" (38.1 mm) thick in a 1-1/2" (38.1 mm) x 6" (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.

## 2.04 FRP RAILINGS

- A. The FRP standard railing system, including connections, shall be designed to meet the configuration and loading requirements of OSHA 1910.23 and IBC with a minimum 2.0 factor of safety.
- B. Guardrail height is 42" (1067mm) from the top of walkway to the top of the guardrail.
- C. The rails and posts shall be:
  - 1. 1 3/4" x 1 3/4" x .125" (50.8 mm x 50.8 mm x 3.81 mm) square tubes with 1 3/4" x 6" bottom plates and angle connectors to vertical subframe support posts with Quad-Head Pedestal caps and threaded adjustment rods set into support legs in sizes indicated or required to accommodate loading requirements.
  - 2. Provide continuous Toe Plates with corner and splice connectors bolted to the rail posts with 1/4 inch diameter stainless steel round head bolt assemblies as per the manufacturer.
  - 3. The pultruded parts shall be made with a fire retardant resin that achieves a flame spread rating of 25 or less in accordance with ASTM test method E84, flammability characteristics of UL 94 V0 and meet the self-extinguishing requirement of ASTM D635. The resin matrix shall be polyester and shall contain a UV inhibitor. The color shall be chosen by owner from manufacturer's standard colors.
- D. The SAFRAIL fiberglass standard railing system shall be fabricated into finished sections by fabricating and joining together the pultruded square tube using glass-reinforced thermoset components; epoxy bonded and connected as shown in the fabrication details. Railing sections shall be fabricated to the size shown on the approved fabrication drawings and shall be piece marked with a water proof tag.
- E. For Side Mount: Post shall be constructed with a pultruded bottom plug. Length shall be sufficient to extend a minimum of 1" (25.4 mm) beyond the uppermost bolt hole to prevent crushing of post tubing. Bolt holes shall provide clearance of 1/16" (1.59 mm) for 1/2" (12.7 mm) diameter bolts/studs. On square tubes, holes shall be on longitudinal center line of post, 1" (25.4 mm) from bottom of post (minimum) and not less than 3" (76.2 mm) apart on center. Posts shall be fastened with stainless steel anchor bolts or studs, 1/2" (12.7 mm) diameter.
- F. Post locations shall be no greater than 18" (457 mm), nor less than 9" (229 mm) from horizontal or vertical change in handrail direction. For square tubes, post centers shall be no greater than 60" (1524 mm) apart on any straight run or rail, or 48" (1220 mm) apart on any inclined rail section.

## 2.05 FRP LADDERS

- A. All ladder side rails, rungs, ladder mounting brackets and cage straps are to be FRP structural shapes manufactured by the pultrusion process.
- B. All 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.
- C. The ladder side rail shall be 1-3/4" square tube with a wall thickness of 1/4" or greater. The rungs shall be 1-1/4" diameter pultruded structural shapes, continuously fluted to provide a non-slip surface. Rungs that are gritted as a secondary operation shall not be permitted. Ladder wall and floor mount shall be fabricated from pultruded angles, 3/8" minimum thickness.
- D. All fasteners used in the ladder system are to be Type 316 stainless steel. Rivets will be 18-8 stainless steel.



- E. Type 316 stainless steel bolts shall be provided for attaching wall brackets to the ladder.
- F. All rungs shall be both mechanically attached to the ladder with stainless steel rivets and chemically bonded with epoxy.
- G. All ladder and cage components are to be integrally pigmented yellow. All wall and floor mount brackets shall be Dynaform® ISOFR light gray.

## 2.06 LADDER UP SAFETY POST

- A. Basis-of-Design: Type LU Ladder Safety Post by The BILCO Company, P.O. Box 1203, New Haven, CT 06505, 1-800-366-6530, Fax: 1-203-535-1582, Web: [www.bilco.com](http://www.bilco.com). Comply with the following:
  - 1. Furnish and install where indicated on plans ladder safety post Model LU-1. The ladder safety post shall be pre-assembled from the manufacturer.
  - 2. Performance characteristics:
    - a. Tubular post shall lock automatically when fully extended.
    - b. Safety post shall have controlled upward and downward movement.
    - c. Release lever shall disengage the post to allow it to be returned to its lowered position.
    - d. Post shall have adjustable mounting brackets to fit ladder rung spacing up to 14-inches on center and clamp brackets to accommodate ladder rungs up to 1-3/4-inches in diameter.
  - 3. Post: Shall be manufactured of high strength square tubing. A pull up loop shall be provided at the upper end of the post to facilitate raising the post.
  - 4. Material of construction: Shall be steel.
  - 5. Balancing spring: A stainless steel spring balancing mechanism shall be provided to provide smooth, easy, controlled operation when raising and lowering the safety post.
  - 6. Hardware: All mounting hardware shall be Type 316 stainless steel.
  - 7. Finishes: Factory finish shall be yellow powder coat steel.

## 2.07 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" x 6" 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" 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" 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" thick with a tolerance of plus or minus 1/16".
- F. Mesh Configuration: 1-1/2" x 6" rectangular mesh pattern with double cross bars on 6" 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.

## 2.08 FABRICATION

- A. Mold Material: Metal type.
- B. Finish other surfaces not in contact with the mold to match the molded surfaces in appearance.
- C. Finish trim corners and edges.
- D. Cure components prior to shipment and remove material that may be toxic to plant or animal life.
- E. The fabricated railing sections shall be supplied complete with fittings by the FRP manufacturer. The components used to join fabricated sections together may be shipped loose, to be epoxied and riveted together in the field by the contractor.
- F. All ladder rungs shall penetrate the wall of the tube side rails and shall be connected to the rails with both epoxy and rivets to provide both a chemical and mechanical lock, respectively.
- G. Ladders shall be fully shop assembled. Ladder cages shall be test assembled and drilled to ensure a proper fit in the field.

## 2.09 FINISH

- A. Color: as selected by the Engineer.
  - 1. Gratings: Dark gray.
  - 2. Stairs and Railings: Yellow.
- B. Exposed to view Surface Texture: Railing surfaces shall be smooth. Grating surfaces shall be non-slip.
  - 1. Floor Gratings: Meniscus top.
  - 2. Stair Treads: Integrally applied grit top.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work and dimensions are as indicated on shop drawings.

## 06820 - GLASS FIBER REINFORCED PLASTIC FABRICATIONS

### 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 068200

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PART 1 - GENERAL

1.01 - SECTION INCLUDES

- A. Access doors.

1.02 - SUBMITTALS

- B. Submit under provisions of Section 01330.
- C. Indicate on shop drawings plan layout, construction details and required clearances.

PART 2 – PRODUCTS

2.01 – RETROFIT ACCESS DOORS

- A. Manufacturers
  - 1. SSR-E by USF Fabrication, Hialeah, FL., or approved equal.
- B. Fabricate door leaf of 3/16" aluminum diamond plate reinforced with aluminum stiffeners as required to withstand 150 psf pedestrian live load.
- C. Aluminum angle frame shall be 3/16" and have a horizontal flange with 7/16-inch diameter holes for bolting to the existing floor and an integral door seat on all four sides. An extruded U-shaped EPDM rubber weatherseal gasket shall be provided where the cover closes on the frame.
- D. The access door shall be equipped with a 316 stainless steel slamlock with fixed exterior and interior handles and interior padlock staple. A 316 stainless steel hold open arm with push/pull handle shall automatically keep the cover in its upright, open position.
- E. The door shall have stainless steel gas shocks to assist in opening the door and reducing the force during closing.
- F. Staple for a padlock shall be supplied for security.
- G. Provide two (2) removable square key wrenches.
- H. Hardware: 316 stainless steel.
- I. Factory Finish: Mill finish with bituminous coating applied to exterior of frame. Hinges fabricated with aluminum lugs and 316 stainless steel pins.

## 08310 - ACCESS DOORS

- J. A hinged Protective grating panel as manufactured by USF Fabrication, of Hialeah, Florida
  - 1. Secondary protective grating panel shall be 1-1/2-in. "I" bar aluminum grating.
  - 2. Grating panel color and finish shall be Safety Orange powder- coating.
  - 3. Grating panel shall be hinged and shall be supplied with positive latch to maintain unit in an upright position. Panel shall be hinged to open in the same direction of the access door to limit obstruction of the opening.
  - 4. A 4-in. by 6-in. viewing area shall be provided on each lateral unhinged side of grating panel, for visual observation and limited maintenance procedures.
  - 5. On 300 lbs. psf load rating access covers, only, grating support ledges shall incorporate nut rail feature supplied with minimum of four (4) stainless steel spring nuts for mounting pump brackets and/or cable holders.
  - 6. A padlock hasp for owner-supplied padlock shall be provided.
- K. Guarantee access doors against defects in material and workmanship for a period of ten (10) years.

## PART 3 - EXECUTION

### 3.01 - INSTALLATION

- A. Install access doors and safety grating in accordance with manufacturer's instructions.

END OF SECTION 08310

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. The work of this section shall include, but not be limited to the following:
  - 1. Metal louvers and frames.
  - 2. Bird and insect screening.

1.02 RELATED SECTIONS

- A. Mechanical: Division 15.

1.03 REFERENCES

- A. AMCA 500 (Air Movement Control Association) - Test Method for Louvers.
- B. ASTM B221 – Aluminum Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
- C. SMACNA – Architectural Sheet Metal Manual.

1.04 PERFORMANCE REQUIREMENTS

- A. Design and fabricate units to withstand wind lateral loads and snow loads.

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.

### 2.02 FIXED LOUVERS

- A. Louvers shall be fabricated to provide a minimum of (57%), 9.09 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 886 feet per minute, with .125 inches of water gauge pressure drop for air intake. Louvers shall have a full width sill with head and blades contained within jambs. Louver shall be approximately 4" deep.
- B. Louvers shall be provided with an aluminum bird or insect screen as called for on equipment schedules.
- C. Material: Extruded Aluminum 6063 – T6/T52 Alloy.
- D. Louver finish shall be Kynar, color as selected by Owner.
- E. Louvers shall be Type EA-400 by Arrow United or approved equal.

## 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.
- B. Install louvers level and plumb.
- C. Install flashings and align assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
- D. Secure louvers in opening framing with concealed fasteners.
- E. Install screens and frame to interior of louver where indicated.



## 08919 - HVAC LOUVERS

- F. Install perimeter sealant and backing rod.

### 3.03 ADJUSTING AND CLEANING

- A. Clean work under provisions of 01710.
- 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 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 08919

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## PART 1 GENERAL

### 1.01 SECTION INCLUDES

- A. Requirements to supply labor, materials, equipment and services necessary to paint all required surfaces.
- B. Paint before installation of equipment and piping
  - 1. Only touch-up painting will be allowed after the installation of: equipment, pipes, grating, handrails, furnishings, panels, conduit, electrical boxes, electrical equipment, conduits, HVAC duct, HVAC equipment, plumbing and plumbing accessories, and the like.
  - 2. Interior doors, wall louvers, and windows shall not be installed until after all painting is completed in an area.
- C. The following items shall be painted:
  - 1. Ferrous metals.
  - 2. Access doors and panels (miscellaneous trim and surfaces not pre-finished).
  - 3. Small diameter pipes, fittings and valves regardless of pipe material.
  - 4. Exposed process pipes, valves, and fittings (large diameter piping) except stainless steel.
  - 5. Miscellaneous mechanical and electrical equipment as specified herein.
  - 6. Products specified to be painted in other Technical Specification Sections.
  - 7. Truss walkway modifications.
- D. Items not scheduled for painting include:
  - 1. Buried concrete walls and other surfaces.
  - 2. Anodized aluminum surfaces and grating.
  - 3. Motors and equipment, such as pumps, motors, motorized valve actuators, etc. furnished in final coats by the factory.
  - 4. Stainless steel.
- E. Pre-finished surfaces Painting shall be scheduled and coordinated, through the Engineer, and shall not begin until other work and/or job conditions are completed to the satisfaction of the Engineer.

### 1.02 RELATED SECTIONS

- A. Section 01300 – Submittals
- B. Section 03300 – Cast-in-Place Concrete

### 1.03 REFERENCES

- A. New York State Department of Environmental Conservation for VOC Compliance.
- B. The Society for Protective Coatings (SSPC) Volume 2
  - 1. Chapter 2 - Surface Preparation
  - 2. Chapter 5 - Paint Application Specifications

### 1.04 QUALITY ASSURANCE

- A. The paint shall be furnished by one single supplier (Paint Manufacturer).
- B. Consideration will only be given to suppliers who can demonstrate that their paint system complies with these specifications having had successful and documented experience of the size,

quality, performance and reliability to that specified, and who can successfully demonstrate this criteria to the Engineer.

- C. The brand name products specified were chosen based on past performance, and constitute a standard for quality and performance for the specific purpose for which they are intended. Products other than that specified will be considered for use under the provisions set forth as follows:
1. The named products constitute the "Base Bid" system. All bidders are advised to provide "Base Bid" pricing since the magnitude of the expenses involved with engineering redesign or modifications may be difficult to determine during the bidding period.
  2. If an alternate paint system is proposed, prepare and submit to the Engineer three (3) copies of the "Evaluation Documentation" as listed below. The information shall be in a form that is neat, clear, precise, legible and computer drafted and prepared so as to allow the Engineer to evaluate the proposed equipment. The "Evaluation Documentation" shall be hand delivered directly to the Engineer at least twenty one (21) calendar days prior to the date set for the bid opening. The pre-bid "Evaluation Documentation" shall consist of the following:
    - a. Data substantiated by certified tests, conducted at no expense to the Owner, to demonstrate that the quality of the proposed product is equal to the requirements contained herein for each paint listed in the attached schedule.
    - b. Technical data sheets for the proposed products and manufacturer's standard color chart showing availability of all coatings listed in the attached schedule.
    - c. Two (2) paper chip samples, illustrating range of colors available for each surface-finishing product listed in the attached schedule.
    - d. Descriptive technical information for the proposed product(s) highlighted to show the differences between the proposed the specified product. Descriptive technical information shall include volume solids, dry film thickness, curing time, storage temperature, coverage rates, pot life, and surface preparation requirements.
    - e. List of facilities showing facility name, active contact name and telephone number, years in service, design conditions and parameters and design engineer's name and current telephone number of the company.
    - f. The documentation shall include a statement that Supplier is in compliance with each and all Sections of the Specifications. Any variance from the specified system shall be listed and a description of each variance must be in letter form.
- D. Facsimile transmissions will not be accepted.
- E. Failure to submit the above listed information twenty (20) calendar days prior to the date set for the bid opening shall be cause for non-evaluation and the paint system will not be considered for the project.
- F. The Engineer will issue an addendum of approved products prior to the date set for the bid opening.
- G. The acceptance of products prior to the bid date does not relieve the Contractor of his/her responsibility regarding the performance or ability to meet the requirements of the Contract Documents.

#### 1.05 WARRANTY

- A. Provide a warranty certificate typed on company letterhead and signed by an officer of the paint applicator. The certificate shall be witnessed by a notary public in the state in which the company headquarters is located.
- B. The applicator shall guarantee the paint system to be free from any defect for a period of two (2) year commencing on the date of substantial completion.

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- C. During the guarantee period, if the paint system fails to perform or shows signs of a defective application, the applicator shall repaint such defective surfaces free of any and all charges. The cost of labor and all other expenses resulting from the repainting shall be borne solely by the paint applicator. The application of the paint system shall be covered under the Contractor's maintenance bond.

### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the requirements contained in Section 016500 - Product Delivery, Storage and Handling.
- B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability. Deliver application instructions to the Engineer.
- C. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- D. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.
- E. Cover all building openings to achieve specified temperatures. Furnish and install temporary heaters and electric feed to maintain room temperatures. The use of propane heaters will be allowed when approved by the Engineer.

### 1.07 FIELD SERVICES

- A. Supply and credit to the Owner the costs for field services as specified in Section 01660 - Quality Control.
- B. The following field services shall be provided as a minimum in accordance with the requirements contained in Section 01650 - Starting of Systems:
  - 1. One (1) days totaling one (1) trip for providing storage, preparation and application instruction to the Contractor' applicator. At this time, the preparation of the surfaces, the application requirements and the temperature / environmental requirements shall be discussed with the Engineer, Contractor, and applicator.
  - 2. One (1) day to inspect the completed application.

### 1.08 SUBMITTALS

- A. Comply with the requirements contained in Section 01300 - Submittals. The following documents shall be submitted:
  - 1. Technical data sheets for each paint specified.
  - 2. Color charts showing availability of each paint specified in the attached schedule.
  - 3. Two (2) paper chip samples, illustrating range of colors available for each paint specified in the schedule.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. The requirements listed in this specification are based on paint provided by Tnemec Co., Inc. and are provided as a basis of the bid.

## 09910 – PAINTING

### 2.02 MATERIALS

- A. Refer to the attached schedule for a listing of the appropriate surfaces for each paint material. The following are the types of materials that shall be used:
- |                               |  |
|-------------------------------|--|
| 1. V69 Epoxoline II           | Hi-build polyamidoamine cured epoxy                    |
| 2. 73 Endura-Shield III       | Hi-build aliphatic polyurethane                        |
| 3. 280 Tneme-Glaze            | 100% solids, hi-build amine epoxy (orange peel finish) |
| 4. 46H-413 Hi-Build Tneme Tar | Hi-build coal tar epoxy                                |
| 5. 201 Epoxoprime             | 100% solids clear epoxy primer                         |
| 6. 1 Omnithane                | Aromatic urethane primer with MIOX                     |
| 7. 1028 Enduratone            | Water-based acrylic polymer                            |
- B. Colors shall be as selected by the Engineer

### 2.03 MIXING

- A. Mixing or tinting shall be done at the factory.
- B. Site mixing shall be prohibited.

### 2.04 ACCESSORY MATERIALS

- A. Provide all required ladders, scaffolding, drop cloths, mask-ings, scrapers, tools, sandpaper, dusters, cleaning solvents, and miscellaneous equipment as required to perform the work and achieve the results specified herein.

### 2.05 MISCELLANEOUS MATERIAL

- A. Furnish the following in accordance with the requirements contained in Section 01600:
1. One (1) gallons of each color, type, and surface texture used on the project regardless of the quantity actually applied. Store this spare paint where directed by the Engineer. Label each container with color, type, texture, and room location, in addition to the manufacturer's label.
  2. This material shall be turned over to the Engineer/Owner prior to substantial completion.

## PART 3 EXECUTION

### 3.01 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- C. Apply exterior paint only when temperature exceeds 50 degrees F or as otherwise required by manufacturer and drying conditions are good and predicted to remain so for at least 24 hours.
- D. Apply interior paint only when inside space and surface temperatures exceed 60degrees F, or as required by manufacturer, and will be maintained above that point until paint has dried.
- E. Provide and maintain application temperatures for all finishes.
- F. Contractor to provide adequate light, heat, dehumidification and ventilation for proper application and cure of all coatings.

### 3.02 EXAMINATION

- A. Before painting is started in any area, the area shall be cleaned and excessive dust shall be removed from all areas to be painted. After painting operations begin in a given area, clean only with commercial heavy-duty vacuum cleaning equipment.
- B. All steel joists and ceiling deck shall be high pressure washed with a solvent to remove all factory oils.
- C. All concrete shall be finished as specified prior to paint application.
- D. Adequate illumination and ventilation shall be provided in all areas where painting operations are in progress.
- E. Verify the surfaces are ready to receive the work as required by the product manufacturer.
- F. Before starting any work, surfaces to receive paint finish shall be examined carefully for defects which cannot be corrected by the procedures specified herein and which might prevent satisfactory painting results. Work shall not proceed until such damages are corrected.
- G. The commencing of work in a specific area only shall be construed as acceptance of the surfaces, and thereafter the Contractor's applicator shall be fully responsible for satisfactory work as required herein.
- H. Test shop applied primer for compatibility with subsequent cover materials.
- I. Do not begin work until surfaces to receive paint are dry, firm, sound, clean and free of defects or blemishes, which would adversely affect the quality or appearance of the finished work.
- J. Beginning of work means the installer accepts existing surface conditions.
- K. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
  - 1. Masonry and concrete unit masonry: 12 percent.
  - 2. Concrete floors and walls: 8 percent.
  - 3. Interior and Exterior Wood: 15 percent, measured in accordance with ASTM D4442

### 3.03 PREPARATION - GENERAL

- A. All surfaces shall be prepared as specified in the attached schedule. Surface preparation of steel shall be in accordance with SSPC - Chapter 2 - Surface Preparation Specifications.
- B. Galvanized surfaces: Remove surface contamination and oils and wash with solvent. Abrade by abrasive blasting or power tools to provide a rough surface as described in coating schedule.
- C. Uncoated ferrous surfaces: To be cleaned to SSPC SP11 power tool clean to bare metal and wash clean with solvent. Prime paint after repairs.
- D. Concrete: All exposed concrete shall be installed with the intent that it will be painted. All bug holes and honeycombed areas shall be patched as specified in Section 033000.
- E. Surface appurtenances: If allowed by the Engineer, remove or mask electrical plates, hardware, light fixture trim, escutcheons, fittings, and all other surfaces to be protected from paint prior to preparing surfaces or finishing.

## 09910 – PAINTING

- F. Surfaces: Correct defects and clean surfaces, which affect work of this Section. Remove or repair existing coatings that exhibit surface defects.
- G. Aluminum Surfaces receiving Bitumastic Paint: Remove surface contamination and oils and wash with solvent.
- H. Follow manufacturer's recommendations for preparing surfaces to be primed and painted.
- I. Clean and sand surfaces to be painted.
- J. Mask, cover, or remove surfaces to be protected from paint. Protect electrical and mechanical equipment and systems not to be painted.
- K. Do not paint over UL Labels, manufacturer installed equipment nameplates, factory installed nameplates and equipment identification plates.
- L. Clean and remove scale, oil or grease from ferrous metal surfaces

### 3.04 APPLICATION

- A. Apply paint in accordance with SSPC - Chapter 5 - Paint Application Specifications.
- B. It is the intent that the above brand names and types of material will give complete coverage with uniform appearance. If any additional coat is necessary for complete coverage and appearance, it shall be done at no additional cost.
- C. All paints shall be new stock, delivered to the site unopened. Prepare surfaces properly for receiving paint; protect adjacent surfaces not to be painted.
- D. Use of sprays may be permissible, upon prior approval by Engineer.
- E. All work shall be carefully done by skilled painters. Finished surfaces to be uniform in coverage, gloss, finish, and color, and free from brush marks and blemishes. All coats shall be thoroughly dry before applying succeeding coats.
- F. Apply products in accordance with manufacturer's instructions.
- G. Do not apply finish coats until paintable sealant is applied.
- H. Do not apply sealant or primer until surfaces are properly prepared.
- I. Spray, roller and/or brush may be used as appropriate for the various conditions, but the specified dry film thicknesses must be provided.
- J. Thicknesses listed in the Schedule for High Build Coatings can be obtained in one coat by spray, but not necessarily by brush or roller.
- K. The specified DFT shall hold precedence over whatever recommendations are made for other supplier's products.
- L. Minimum air and surface temperature for application of epoxy coatings shall be maintained at 55 degrees F. unless otherwise noted on the manufacturer's product data sheet.
- M. Minimum air and surface temperature for 100% solids by volume epoxy coatings, such as 280 Tneme-Glaze, etc. shall be 60 degrees F. Optimum temperature of unopened 100% solids epoxy



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shall be 75 degrees F. Minimum temperature of unopened 100 solids epoxy shall be 60 degrees F.

- N. Heat shall be supplied by equipment that delivers clean, warm air into the space to be coated. Heat shall not be supplied by devices that give off exhaust fumes such as carbon dioxide or carbon monoxide into the area to be coated. The purpose of this requirement is to prevent the coatings from yellowing during application and cure.
- O. Sand surfaces lightly between coats to achieve required finish.
- P. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- Q. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- R. Prime concealed surfaces of interior and exterior woodwork with primer paint.
- S. Apply materials to obtain:
  - 1. Owner's satisfaction and approval.
  - 2. Smooth uniform appearance.
  - 3. Complete coverage.
  - 4. Match with approved color sample.
  - 5. Work free of runs, sags, holidays, and skips.
  - 6. Sharp, clean edges where finishes or colors change.
  - 7. Surfaces free of defects and damage at time of acceptance.
- T. Paint PVC pipe in accordance with recommendations of the paint manufacturer and apply primer.

### 3.05 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Paint shop primed equipment.
- B. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- C. Prime and paint insulated and exposed process pipes, fittings, valves, hangers, brackets, collars and supports, except where items are shop finished.
- D. Paint both sides and edges of plywood backboards of electrical and telephone equipment before installing equipment.
- E. Color code equipment, piping, conduit, and exposed ductwork in accordance with other Sections, as shown or noted on the Drawings or as directed by the Engineer

### 3.06 ACCEPTANCE OF COATINGS

- A. The appearance of all coatings shall be subject to comparison to the submitted paper chip samples. Acceptance of finish shall be made by the Engineer based on these comparisons.

### 3.07 CLEAN UP

- A. Comply with the requirements contained in Section 01710 - Cleaning.

## 09910 – PAINTING

- B. Collect waste material, which may constitute a fire hazard, place in closed metal containers, and remove daily from site.
- C. Install finished items removed by this Section. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
- D. Remove all masking, glue and protective covering.
- E. Leave factory finish surfaces clean and free of paint.

### 3.08 SCHEDULE

- A. Ferrous Metals, Interior, Non-Submerged (including, but not limited to, structural steel, miscellaneous steel and process ductile iron piping, valves and fittings)
  - 1. Surface Preparation - SSPC-SP6, Commercial Blast Cleaning, 2-mil anchor pattern.
  - 2. Shop Primer - #1 Omnithane, 2.5-3.5 mils DFT
  - 3. Field Touch Up and stripe coat - L69 Epoxoline II, 3-5 mils in finish color.
  - 4. Finish - L69 Epoxoline II, Hi-Build (to color), 4-6 mils DFT, or 2 coats @ 2-3 mils by brush and/or roller.
  - 5. Notes:
    - a. Color code process pipes then apply mechanical identification.
    - b. Coordinate the work such that the prime coat specified is for process piping.
    - c. Paint piping before insulation is installed. Paint all air pipe insulation in addition to painting all piping.
- B. Ferrous Metals, Interior and Exterior, submerged or intermittently submerged in liquids (raw sewage or potable water applications).
  - 1. Surface Preparation - SSPC-SP10, Near White Metal blast cleaning, 1-2 mil anchor pattern.
  - 2. Shop Primer - #1 Omnithane at 2.5 to 3.5 mils DFT
  - 3. Touch Up - #1 Omnithane at 2.5 to 3.5 mils DFT. All primer shall be abraded if finish is not applied within 14 days.
  - 4. Stripe Coat – L69 Epoxoline II (contrasting color to Finish)
  - 5. Finish - L69 Epoxoline II (to color) 2 coats 4-6 mils DFT per coat or V140 Pota-Pox Plus 2 coats 4-6 mils DFT per coat.
  - 6. Notes:
    - a. Includes, but is not limited to, process piping, valves, and fittings.
- C. Hollow Metal Work, Interior
  - 1. Surface Preparation - SSPC-SP2 Hand Tool Cleaning
  - 2. Shop Primer – Manufacturer's standard primer, 2.0 to 3.0 mils DFT
  - 3. Field Intermediate: 1028 Enduratone (to color), 2.0 to 3.0 mils DFT
  - 4. Finish – 1028 Enduratone (to color) 2.0 to 3.0 mils DFT
- D. Ferrous Metals, Exterior, Non-submerged
  - 1. Surface Preparation - SSPC-SP6 Commercial Blast cleaning, 1-2 mil anchor pattern
  - 2. Shop Primer - #1 Omnithane, 2.5 to 3.5 mils DFT
  - 3. Stripe Coat – L69 Epoxoline II (contrasting color to Finish)
  - 4. Field Intermediate - L69 Epoxoline II (to color) 3.0 to 5 mils DFT
  - 5. Field Finish - 1095 Endura-Shield , 2.0 to 3.0 mils DFT
  - 6. Notes:
    - a. Includes process piping, valves, and fittings.
- E. Galvanized and Aluminum Surfaces, Exterior
  - 1. Surface Preparation - SSPC-SP-1 Solvent Cleaning

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- a. Abrasive blasting per ASTM D6386, Standard Method for Preparing Galvanizing. When not possible to blast, use SSPC-SP2 Hand Tool Cleaning and sanding for all rust spots (white rust or aluminum oxide) and to roughen all surfaces.
  2. Primer - L69 Epoxoline II (to color) 2.0 to 3.0 mils DFT
  3. Finish - 1095 Endura-Shield , 2.0 to 3.0 mils DFT
  4. Notes:
    - a. Includes structural members/shapes/angles, and galvanized members/shapes/ angles.
    - b. Excludes grating and aluminum equipment components.
- F. Hollow metal work, Exterior
1. Surface Preparation - SSPC-SP2 Hand Tool Cleaning
  2. Shop Primer – Manufacturers standard compatible with epoxy or urethane field coats, 2.0 to 3.0 mils DFT
  3. Field Intermediate – 1095 Endura-Shield (to color) 2.0 to 3.0 mils DFT
  4. Finish – 1095 Endura-Shield, 2.0 to 3.0 mils DFT
- G. Ferrous Metals, Buried, Exterior (including structural steel, and miscellaneous steel)
1. Surface Preparation - SSPC-SP10 Near White Metal Blasting, 1-2 mil anchor pattern.
  2. Stripe Coat – L69 Epoxoline II (contrasting color to Finish)
  3. Shop Primer - L69 Epoxoline II, Hi-Build, Apple Red, 3-5 mils DFT
  4. Field Finish - 46H-413 Hi-Build Tneme-Tar, 14 to 20 mils DFT
- H. Concrete Walls and Ceilings, Interior, Poured and Precast, non-submerged
1. Surface Preparation - Allow to cure 28 days, if new. Remove all oil, grease, loose mortar, mortar splatter, and all loose foreign matter. Moisture level to be below manufacturer's requirements. Provide a minimum ICRI-CSP 3 or greater profile.
  2. Primer - 201 Epoxoprime, clear at 5-6 mils DFT. 201 with 211 filler can be used to fill air holes simultaneous with priming.
  3. Finish - 280 Tneme-Glaze (to color) one coat at 8.0 - 10.0 mils DFT
- I. Concrete Wet Well Interior (raw sewage or potable water applications).
1. Surface Preparation - Allow to cure 28 days, if new. Remove all oil, grease, loose mortar, mortar splatter, and all loose foreign matter. Moisture level to be below manufacturer's requirements. Provide a minimum ICRI-CSP 3 or greater profile .
  2. Primer – Series L69 Epoxoline II
  3. Finish – Series L69 Epoxoline II , 2.0 – 6.0 mils DFT
  4. Notes:
    - a. Includes, but is not limited to interior concrete surface of wet well.
- J. Small diameter PVC Piping, Interior & Exterior
1. Surface Preparation – SSPC-SP1 “Solvent Cleaning” followed by abrasive sanding.
  2. Field Primer – Series 115 Uni-Bond DF at 2-4 mils.
  3. Finish (2 coats) – Series 1028 Enduratone at 2-3 mils.

END OF SECTION 09100

09910 – PAINTING

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## 11316 – SEWAGE PUMPS

### PART 1 - GENERAL

#### 1.01 DESCRIPTION

- A. Furnish, install, test and place in satisfactory operation, as shown on the Plans and specified herein, dry-pit submersible sewage pumps complete with all appurtenances and accessories and spare parts to produce a complete and workable installation.

#### 1.02 REFERENCES

- A. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
  - 1. ASTM A48 - Gray Iron Castings.
  - 2. NFPA 70 – National Electric Code
  - 3. Hydraulic Institute Standards
  - 4. National Electrical Manufacturers Association
  - 5. Institute of Electrical and Electronic Engineers
  - 6. American National Standards Institute
  - 7. NEMA ICS 1 - General Standards for Industrial Control and Systems.
  - 8. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.
  - 9. NEMA ICS 3 - Industrial Systems.
  - 10. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

#### 1.03 SERVICE CONDITIONS

- A. All components of the system shall be designed for continuous duty.
- B. Provisions shall be made for lubrication, adjustments, or replacement of all parts. Corresponding parts of multiple units shall be interchangeable.

#### 1.04 SUBMITTALS

- A. Submit information in accordance with the requirements in Section 01300.
- B. Submit the following:
  - 1. Pump curves for the units supplied, showing Total Dynamic Head, Pump Efficiency, Brake Horsepower, Power Input to Electric Drive Motor of Pumping Unit for the various conditions under which the units are to operate including duty point along with descriptive data and specifications describing in detail the construction of the complete units.
  - 2. VFD head curve analysis at 40 Hz to 60 Hz in 5 Hz increments with one, two and three pumps in operation.
  - 3. Shop drawings, showing all weights and dimensions necessary for the installation of foundations, anchor bolts, piping and valve connections.
  - 4. Electrical data sheet for pump motor.
  - 5. Field-wiring diagram for pump motor and control wiring.
  - 6. Catalog cuts and/or engineering data for each accessory item specified to be provided herein and a written description of each spare part.
  - 7. Storage, handling and installation instructions.
  - 8. Warranty Certificate in the form specified herein.
  - 9. Certified pump curve for each pump after the pump is constructed and before shipment to the project site. The plot shall be prepared in accordance with the standards of the Hydraulic Institute.
  - 10. Manufacturer Startup Report (MSR's) as specified in Section 01720.

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11. Submit an operation and maintenance manual in accordance with the requirements in Section 01730.

### 1.05 QUALITY ASSURANCE

- A. The pump and accessories specified herein shall be furnished by one single supplier (manufacturer). This requires the supplier to be responsible for the development, design, fabrication, assembly, delivery, and proper sustained automatic operation of the pumping system. The pump, motor, and mechanical seals shall all be designed, manufactured, and warranted by the pump manufacturer.
- B. The submersible sewage pumps specified herein and as shown to be installed on the Contract Drawings, are manufactured by Xylem/FLYGT. The specified unit provides a standard of quality, specification dimensions and performance required for this project.
- C. Acceptable alternate manufacturers for submersible sewage pumps include ABS / Sulzer, KSB and Grundfos. The listing of these alternate manufactures does not guarantee the acceptability of the entire product line for that manufacturer. The specific equipment must be of equal quality and performance. By listing one of the substitute products in his/her bid, the Contractor understands that he/she is ultimately responsible for all design modifications and associated costs that may be required to adapt, modify, and otherwise satisfy the design and operating requirements.
- D. Any other proposed substitutions from manufacturers other than those listed will require full compliance with the requirements of Article GC17 – Materials and Equipment, Approvals, Substitutions and Deviations.
- E. After the bid opening, consideration will only be given to other alternate manufacturers/suppliers who can demonstrate to the Engineer that their equipment complies with these Specifications and has had successful and documented experience with the size, quality, performance and reliability to that specified consideration for any other alternate manufacturer shall include the proposed equipment's application and ability to provide equal service and performance as intended by these specifications. All modifications to structures, piping, valves, equipment layout, electrical connections, wiring (runs, wire sizes, service circuit sizes) and coordination with ancillary or interconnected systems or equipment necessitated by a substitution shall be reviewed and approved by the Engineer at the cost of the Contractor.
- F. The manufacturer shall have a minimum of five installations of the exact pump and motor model proposed to be furnished for this project. Installations must be in operation for a minimum of five years and shall list the pump model, motor model and horsepower, date of installation, duty point, and contact information including telephone number. A list of these installations shall be furnished to the Engineer with submittals.
- G. The system shall be designed, furnished, and installed to achieve the conditions of service specified herein.
- H. The manufacturer shall have at least ten (10) years of experience in the design and manufacturing of raw sewage, non-clog, and submersible pumps.
- I. The cost for any construction modifications shall be included in the cost as bid and no additional cost shall be paid by the Owner for acceptance of alternate equipment and any required installation modifications.

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- J. Coordinate and provide all transportation and lodging during one trip to the pump manufacturer's facility for the Owner and an Owner's engineering representative to witness the testing needed to conduct the performance test for the certified pump curve for all pumps to be furnished.

### 1.06 FIELD SERVICES

- A. Supply and credit to the Owner field services.
- B. Provide the following field services as a minimum at each site:
  - 1. One (1) day for providing installation supervision to the Contractor per pump station.
  - 2. Two (2) days totaling two (2) trips for a total of four (4) days and four (4) trips once each Pump Station has been installed to check the completed installations, make all necessary adjustments, and otherwise place the system into permanent operation. Electrical wiring of pump power and control cords shall be verified by the representative. During one of these trips, and before substantial completion, provide operation and maintenance instruction to the Owner. A complete review of the Operations and Maintenance Manual shall be presented at this time.

### 1.07 WARRANTY

- A. Provide a warranty certificate typed on manufacturer's letterhead and signed by an officer of the manufacturer. The certificate shall be witnessed by a notary public in the state in which the company headquarters is located.
- B. The manufacturer's standard five (5) year warranty on the pump and motor shall apply. The initial year from start-up of the equipment shall be covered 100% for parts and labor. The following years 2 through 5 shall be covered 50% for parts and labor. The warranty shall not be limited by hours of running time.
- C. In addition, the manufacturer shall guarantee all components of the equipment specified to be furnished under this Section to be free from defects in design, materials, and workmanship for a period of one (1) year commencing on the date of the Manufacturer's Startup Report. That being the day that the pump and monitoring unit was placed into permanent, automatic, and consistent, fault free operation.
- D. During the guarantee period, if any part or equipment component is defective or fails to perform when operating at design conditions and if the equipment has been installed and is being operated and maintained in accordance with the written instructions provided by the manufacturer(s), the supplier shall repair or exchange, at the discretion of the Owner, such defective part(s) free of any and all charges. The cost of labor and all other expenses resulting from the repair or replacement of the defective part(s) and from installation of part(s) furnished by this Warranty shall be borne solely by the supplier.
- E. The manufacturer shall guarantee clog-free operation to the Owner for a period of 12 months from the date of start-up of the pumps by the local authorized factory representative. A certificate shall be provided to the Owner on the day of start up with the local contact information and effective date. Should the impeller clog with typical solids and debris normally found in domestic wastewater during this period, an authorized representative shall either travel to the jobsite to remove the pump, clear the obstruction and reinstall the pump at no cost or reimburse the Owner for reasonable cost to provide this service. A written report shall be provided to the Owner detailing the service call with pictures for verification purposes.

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### 1.08 EXTRA MATERIALS

- A. Supply the following spare parts to match the pumps provided under Part 2 of this Section:
  - 1. Basic Repair Kit – Quantity Ten (10) – including mechanical seals, washers, retaining ring, bearings and O-Ring kit
  - 2. Pump Controls – Quantity Two (2) – note this is representative of the basis of design manufacturer (Xylem/FLYGT). If alternate pump manufacturer is selected, spare parts shall be provided for pump controls that is a full replacement of all control modules equivalent for two sets of pumps.
    - 1. MAS 811 Base Unit
    - 2. MAS 801 Central Unit
    - 3. MAS FOP402 Operator Unit
    - 4. Pump Electronic Module (PEM)

## PART 2 - PRODUCTS

### 2.01 MANUFACTURER

- A. Sewage pumps shall be manufactured by Xylem/FLYGT, ABS/Sulzer, KSB, or Grundfos. The basis of design is Xylem/FLYGT.

### 2.02 MANUFACTURED UNITS

- A. Xylem / Flygt: Model NZ 3202 LT 3~ 616 capable of delivering 3,500 U.S. GPM at 38 feet TDH, including 17 feet static head and pipe friction with one of three pumps in operation. Shut off head shall be a minimum of 66 feet. Pump motor shall be 54 HP, 460 volts, 3 phase, 60 Hz, 1,185 RPM submersible explosion proof motor.
- B. ABS / Sulzer: Model XFP 305J-CB2 PE350/6 capable of delivering 3,500 U.S. GPM at 38 feet TDH, including 17 feet static head and pipe friction with one of three pumps in operation. Shut off head shall be a minimum of 67 feet. Pump motor shall be 47 HP, 460 volts, 3 phase, 60 Hz, 1,180 RPM submersible explosion proof motor.
- C. KSB: Model KRT K 250-403/556XFG-DH IE3 capable of delivering 3,500 U.S. GPM at 38 feet TDH, including 17 feet static head and pipe friction with one of three pumps in operation. Shut off head shall be a minimum of 77 feet. Pump motor shall be 50 HP, 460 volts, 3 phase, 60 Hz, 1,192 RPM submersible explosion proof motor.
- D. Grundfos: Model SE/SL.56L.440.6 (ANSI) capable of delivering 3,500 U.S. GPM at 38 feet TDH, including 17 feet static head and pipe friction with one of three pumps in operation. Shut off head shall be a minimum of 80 feet. Pump motor shall be 44 HP, 460 volts, 3 phase, 60 Hz, 1,200 RPM submersible explosion proof motor.

### 2.03 MATERIALS

- A. General Requirements:
  - 1. Each pump shall be equipped with a submersible, electric motor connected for operation. Each pump shall be supplied with submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards and have P-MSHA Approval. The schedules at the end of this Section note the electrical service requirements.
  - 2. Each pump shall include monitoring and recording per section 2.03H and be capable of the following:



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1. Pump shall be supplied with monitoring station for all required signals for each pump to be located in VFD enclosure.
  2. Monitoring station shall be capable of connecting to the existing Plant SCADA System.
  3. A 316 stainless steel service cart shall be provided integral to the mounting for rigid support and removal of rotating assembly from volute without disturbing volute or piping and without the need for hoists or lifting apparatus during maintenance. A controlled, hydraulically operated service cart shall be used which provides simple and controlled extension and retraction and adequate clearance of volute to enable wear ring, impeller, and lower seal replacement without the need for hoists, cable, or pulley systems.
  4. See the schedule for discharge and suction pipe diameter. Each pump shall be capable of achieving the conditions of service specified in the schedule.
  5. Major pump components shall be of cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 316 stainless steel construction. All metal surfaces coming into contact with the pump, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.
  6. The pump shall be equipped with an open lifting hoop suitable for attachment of standard chain fittings. The hoop shall be on ductile iron and shall be rated to lift a minimum of four times the pump weight.
  7. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber o-rings. Fittings shall be the result of controlled compression of rubber O-rings in two planes and o-ring contact of four sides without the requirement of a specific torque limit.
  8. Rectangular cross-sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical o-rings, grease, or other devices shall be used.
- B. Stainless steel nameplates shall be attached to each pump and motor giving pertinent design data, horsepower, voltage, phase, running amps, model, serial numbers, and manufacturer's name. Provide one spare duplicate nameplate for each pump.
- C. Volute:
1. Pump volute(s) shall be single piece cast iron, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller.
  2. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral grooves shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross in each rotation to maintain an unobstructed opening.
  3. Clearance between volute grooved edges and impeller leading edges shall be adjustable.
- D. Impeller
1. Impellers shall be of Hard-Iron™ (ASTM A-532 (Alloy III A)) 25% chrome cast iron, and be dynamically balanced, semi-open, multi-vane, back-swept, screw-shaped, non-clogging designs.
  2. Impellers shall be locked to the shaft, held by an impeller bolt, and shall be coated with alkyd resin primer.
  3. Impeller shall be capable of meeting Ten State Standards requirement for minimum solids passage size of 3 inches.
  3. Mass moment of inertia calculations shall be provided by the pump manufacturer upon request.

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- E. Wear Rings: An insert ring made of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron integral with the volute shall provide effective sealing between the multi-vane semi-open impeller and the volute housing.
- F. Pump Shaft: Pump and motor shaft shall be a solid continuous shaft. The pump shaft shall be an extension of the motor shaft. Couplings or pieced shafts shall not be acceptable. The pump shall be AISI type 431 stainless steel and shall be completely isolated from the pumped liquid. A shaft material of lower quality than 431 stainless steel shall not be used.
- G. The pump shaft shall rotate on at least three grease-lubricated bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing to handle radial loads. The lower bearings shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust. The upper support bearing, provided for radial forces, shall be a single roller. The minimum  $L_{10}$  bearing life shall be 50,000 hours at any usable portion of the pump curve. Single row lower bearings are not acceptable.

## 2.04 MOTORS

### A. Submersible Motors

1. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180 deg. C (356 deg. F). The stator shall be insulated by current-UV-dip impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for submersible pump usage and continuous duty handling pumped media of 40 deg. C (104 deg. F) and capable of up to 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum or copper. The motor shall be explosion-proof.
2. The premium efficiency motor rotor shall have end rings and rotor bars constructed of copper. The premium efficiency motor shall meet the efficiency levels specified in the IEC standard 60034-30 for international efficiency, Class IE3.
3. All motors regardless of pump application shall be provided as variable speed ready, unless noted otherwise.
4. Thermal switches set to open at 125 deg. C (260 deg. F) shall be embedded in the stator end coils to monitor the temperature of each phase winding. Three PT-100 type temperature sensors shall be installed in stator windings, one for each phase. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection for connection to the control panel.
5. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. A mechanical float switch (FLS) shall be mounted in the junction chamber to signal if there is water intrusion. A pump memory module shall be provided and mounted in the junction chamber to record pump run time, number of starts, as well as contain the motor unit performance and manufacturing data and service history. Wire nuts or crimping type connection devices shall not be acceptable. The motor and pump shall be designed and assembled by the same manufacturer.
6. The combined service factor (combined effect of voltage, frequency, and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40 deg. C (104 deg. F) ambient and with a temperature rise not to exceed 80 deg. C.
7. A performance chart shall be provided showing curves for torque, current, power factor,

input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

8. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

B. Bearings:

1. The pump shaft shall rotate on at least three grease-lubricated bearings. The upper bearing shall be a single roller bearing to handle radial loads. The upper bearing shall have an insulated outer ring to provide protection against potential bearing damage from electrically induced currents that can be created especially when the motor is used with a VFD. The outer ring shall have a plasma-spray technique or oxide-ceramic coating that provides an insulating barrier between the bearing face and the bearing housing of the pump.
2. The lower bearing shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust. Housing for lower bearings shall include an independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down.
3. Upper and lower bearings shall have PT-100 sensors for over temperature protection.
4. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump curve.

C. Cooling System

1. Each unit shall be provided with an integral motor cooling system. A type 304 stainless steel motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The cooling liquid shall pass about the stator housing in the closed loop system in turbulent flow providing for superior heat transfer. The cooling system shall have one fill port and one drain port integral to the cooling jacket. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104F (40C), in accordance with NEMA standards. Operational restrictions at temperatures below 104F are not acceptable. Fans, blowers, or auxiliary cooling systems that are mounted external to the pump motor are not acceptable.

D. Mechanical Seals

1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall be a leakage-free seal and shall contain one stationary and one positively driven rotating tungsten-carbide seal ring. The rotating seal ring shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber.
2. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing and shall be capable of operating in either direction of rotation without damage or loss of seal. The position of both mechanical seals shall depend on the shaft.
3. Should both seals fail and allow fluid to enter the stator housing, a port shall be provided to direct that fluid immediately to the stator float switch to shut down the pump and

- activate an alarm. Any intrusion of fluid shall not come into contact with the lower bearings.
  4. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load.
  5. Seal lubricant shall be FDA Approved, non-toxic.
- F. Power and Pump Control Cables: The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box, shown on the Contract Drawings, without the need of any splices. Provide fifteen (15) extra feet in addition to the length between pump motor and junction box for each cable. Coil and bundle excess cable and secure. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.
- G. Cable Entry Seal: The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the cable entry unit, providing a strain relief function. The assembly shall provide ease of changing the cable when necessary, using the same entry seal. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.
- H. Protection
1. In addition to power and earth conductors, the pump motor cables shall contain shielded and twisted leads for digital communication. Communication of signals from pump sensors shall be made on two leads inside the power cable without using a separate multi-wire pilot cable.
  2. The pump monitoring system shall be able to stop pump operation at imminent danger by an interlock relay and shall also alert the user in case of deviating measurement values. The electronic system shall be designed to support the principle of redundancy. Therefore, a separate set of modules should be used to monitor each pump. In the event a module fails, this will not affect the operation of other pumps in the station. When a pump-related alarm is generated, the system shall support the user in the form of measurement data linked to the specific alarm item for analysis, text information about possible root cause errors and remedial actions. The system shall support the service and maintenance policy that applies to the pump by generating service reminders and graphically providing users with an overview of service status that facilitates planning of upcoming service.
  3. A pump electronic module should be installed in the pump providing for connection of pump sensors as well as measurement and logging. Measurement values and other information shall be exchanged with a base unit in the VFD cabinet using an interference resistant digital communication bus. The pump electronic module shall contain information about the pump as well as features for startup and service support including:
    - a. The pump serial number and other data plate information
    - b. Specific configuration of monitoring functions for the actual pump such as alarm limits, delays, reset types, etc.
    - c. Counters by which the system can generate service reminders in accordance with the service policy specified in the pump manual.
    - d. Data, operating statistics and alarms list with associated so-called black box to

see the condition of the pump and enable quick troubleshooting and reporting.

The PEM database shall, for all monitoring channels, contain measurements taken each second and averaged data for effective analysis and troubleshooting. A max value is the highest measurement value or resolution “second” within the averaged period, while a min-value is the lowest measurement value of resolution “second” within the averaged period.

Time resolution	Time period	Max value	Min value
Second	2 hours	-	-
Minute averages	1 week	*	**
Hour averages	1 year	*	**
24-hour averages	20 years	*	**

*Measurement data linked to alarm events (so-called black box)*

Time resolution	Time period	Max value	Min value
Second	1 hour	-	-
Minute averages	6 hours	*	**

4. The pump shall be equipped with the following sensors as standard:
  - a. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 125 deg. C (260 deg. F) the thermal switches shall open, stop the motor, and activate an alarm. The stator shall also include temperature probe to provide monitoring of the stator temperature.
  - b. A lower bearing temperature sensor shall be provided. The sensor shall directly connect the outer face of the thrust bearing providing for accurate temperature monitoring.
  - c. Pt100 for measuring motor temperature in one phase and three phases, Pt100 for measuring temperature in main bearing, current transformer in one phase of measurement of pump current and supplied frequency to the motor, Pt100 for measuring temperature in the support bearing and leakage sensor in the oil housing.
  - d. Two leakage sensors shall be provided to detect water in the stator chamber, inspection chamber or on connection housing. The float leakage sensor (FLS) shall be a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS shall stop the motor and send an alarm to the control panel. Use of voltage sensitive, solid-state sensors and trip temperature above 125 deg. C (260 deg. F) shall not be allowed.
  - e. Each pump shall have three-axis vibration monitoring protection with frequency range 10-600 Hz to allow continuous measurement of the pump's vibration magnitude. Sensor shall be direct current, single axis velocity transducer with 4 – 20 mA output which is directly proportional to the vibration level. Vibration sensor shall be mounted inside the motor's connection chamber and positioned perpendicular to the motor shaft. A visual display and/or monitor, installed in the control panel, shall monitor the vibration level and cause the pump to shut down in the event of excessive vibration. Externally mounted vibration sensors attached to outside of the pump or motor shall not be acceptable.
  - f. Accumulated running time and number of starts and pump duty rate (percentage of operation)
5. The protection signals shall be connected to a Monitoring and Status (MAS) monitoring unit by the pump manufacturer. The MAS shall be designed to be mounted in the VFD enclosure and shall come with a panel-mounted operator interface. The operator interface shall have touch screen HMI and local indication of the status of the alarms within the connected pump unit by LCD screen read-out. Local MAS system change shall

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be made by use of soft-touch keypad or touch screen HMI or local connection by means of a laptop computer. Remote indication of pump unit status shall be possible with connection to customer PLC or via LAN. The unit shall be able to stop the pump if required via an interlocking relay, function as a gateway by relaying data traffic between the pump electronic module and the external communication to SCADA panel and provide for connection of optional measuring modules such as a power meter and other I/O modules. The MAS shall be coordinated with VFD manufacturer.

### 2.05 REMOVAL SYSTEM

- A. Each pump shall have an integral 316 stainless steel telescoping inlet for inspection and visual verification of impeller clearance using a feeler gage. The use of gasketed spool pieces, clamping type fittings, TEEs, or other devices which require removal of fittings and/or potentially impart hydraulic impact to the pump inlet shall not be considered acceptable. All service inlet devices shall be certified hydrostatically tested at the factory and mounted to the pump for the pump working pressure. Pumps that rely on externally adjusted wear plates risk non-uniform adjustment, bearing damage, and which do not facilitate visual impeller inspection will not be acceptable. A pressure gauge connection shall be included standard on telescoping inlet. The volute shall have a conveniently located drain connection to aid with inspection and or maintenance operations.

### 2.06 ACCESSORIES

- A. Cable Holder: Heavy duty, type 316 stainless steel.

### 2.07 FINISHES

- A. Primer and Finish Paint-Shop apply epoxy coating to all exterior ferrous surfaces of the pump and motor.
  - 1. Surface Preparation - Prepare all surfaces to receive coating system. Surfaces shall be free from dust, grease, rust, scale, and other coatings.
  - 2. Primer and Finish Paint - Shop apply to all exterior ferrous surfaces of the pump and motor a single coat of two component epoxy. Coating shall be resistant to sewage of normal pH and contain no more than 3.5 pounds per gallon of VOCs.
  - 3. Finish Coat Color: Gray.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Install pumps plumb and level.
- B. Install motor and pump in accordance with manufacturers installation instructions.
- C. Check of the pump's rotation in the presence of the manufacturer's representative.
- D. Contractor shall follow manufacturer's storage guidelines and recommendations prior to installation and following the witness factory performance test.

### 3.02 SOURCE QUALITY CONTROL

#### A. Pump Shop Tests: Shop test all pumps provided under this Section.

1. Hydrostatically test pump bodies per ANSI/HI 1.6, to the greater of: twice specified pump discharge head at the full speed design point, or 1.5 times pump's shutoff head.

#### 2. Witnessed Factory Performance Test

a. Each pump shall be subject to a witnessed performance shop test to determine the head, capacity, speed, brake horsepower, and efficiency at each condition specified in the Design and Performance Criteria. Pump shall be tested in dry-pit operation. Performance testing shall be done in accordance to HI Level 1U.

b. Performance shop tests shall be witnessed by the Owner's representatives. Owner and Engineer shall be informed of the test dates a minimum of four weeks in advance. Presence of Owner's representatives during testing does not relieve Contractor from complying with the Contract Documents and does not indicate or imply acceptance of the equipment.

c. One Construction Manager and two additional representatives of the Owner shall attend the witness testing. Expenses and costs for witnessing shall be paid by Contractor, including the following:

1) Transportation of Owner and Engineer and Construction Manager personnel to the factory test location and return via commercial airline and ground transportation to and from airports as required.

2) Overnight accommodations (three single occupancy rooms) in a hotel in reasonable proximity to the factory testing location. Room quality to be standard business class.

3) Ground transportation between the hotel and factory testing location.

4) Meals for the duration of the testing. Meal allowance shall not be less than U.S. Internal Revenue Service guidelines.

d. Each pump shall be operated at the rated duty point. Results of the tests shall be shown on a plot of test curves showing head, flow, horsepower, efficiency, and current.

e. Operate each pump at full speed against a closed discharge valve for a minimum of two minutes. Inspect the wear rings for contact by removing the suction cover. Pumps exhibiting contact shall be rejected.

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f. For a single pump, perform an extended pumping test at the full speed design point for a minimum of two hours to verify that the pump will operate at the rated capacity without loss of flow, head, or efficiency.

g. If equipment fails tests, retesting shall be scheduled as soon as possible. Repeat tests until results indicate compliance with the contract documents.

h. Submit copies of all Shop Test results certified by a Professional Engineer and signed by an officer of the manufacturing corporation.

i. Equipment shall not be shipped to the site until the Contractor has received written notification from the Engineer of their acceptance of the results.

### 3.03 FIELD QUALITY CONTROL

- A. After the installation of the pumps, controls, and all appurtenances, and when construction of other units of the pump station will permit, each complete pumping unit will be subject to field tests as specified herein under actual operating conditions.
- B. Field tests shall be conducted by the Contractor under the direct supervision of a qualified factory trained engineer, and in the presence of, and as directed by the Engineer. Provide, calibrate, and install all temporary gauges and meters, make necessary tapped holes in the pipes, and install all temporary piping and wiring required for the field tests.
- C. The field tests shall determine the head, discharge flow and overall efficiency characteristics of each pumping unit and in addition, shall demonstrate that under all conditions of operation each unit:
  - Has not been damaged by transportation or installation.
  - Has been properly installed.
  - Has no mechanical defect.
  - Is in proper alignment.
  - Has been properly connected.
  - Is free of overheating of any parts.
  - Is free of all-objectionable vibration and noise.
  - Is free of overloading of any parts.
- D. Test each electric motor and record operating voltage and amperage. Have the manufacturer's representative record this information on the manufacturer's startup report (MSR).
- E. Submit the MSR for each pump startup for record purposes. Record the model number, serial number, and nameplate data on each MSR. Separate MSR's shall be provided for each pump.
- F. Review use of pump lifting system during startup training for the installation.

### 3.04 SCHEDULE

Quantity:	10
Model Number:	As indicated in section 2.02
Impeller Diameter:	
Flygt:	328 mm
ABS/Sulzer:	344 mm



## 11316 – SEWAGE PUMPS

KSB: 360 mm  
Grundfos: 350 mm

### *PUMPING CHARACTERISTICS:*

The system head curves for a "C" value equal to 100 up to 3 pumps in operation with existing discharge piping are as follows:

	1 pump in operation	2 pumps in operation	3 pumps in operation
Flow (gpm)	3,500	7,000	10,500
Static Head (ft.)	17		
TDH (ft.)	38		

Three pumps in operation, at 100% operating speed and maximum static head, shall deliver a minimum flow of 10,500 gpm at 38 feet TDH. NPSHR shall not exceed 25 feet at any operating condition.

### *PHYSICAL CHARACTERISTICS:*

Pump Discharge and Suction Size (inches) – Flygt, ABS/Sulzer, Grundfos: 12  
Pump Discharge and Suction Size (inches) – KSB: 10

### *ELECTRICAL CHARACTERISTICS:*

Minimum Motor Horsepower (HP): See section 2.02  
Motor Speed (RPM): See section 2.02  
Service Voltage (V): 460  
Frequency (HZ): 60  
Phase: 3

### *NOTES:*

1. Variable Frequency Ready Motor Required
2. Pump control cord separate from power cord.

END OF SECTION 11316

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PART 1 - GENERAL

1.01 – DESCRIPTION

- A. This section includes furnishing and installing new circular spiral scraper cage drive clarifiers. Collector mechanisms to fit each of the twelve (12) existing 110 foot diameter concrete Final Sedimentation Tanks. All existing equipment shall be removed and disposed.
- B. Generally, the units furnished shall include center drive unit and torque control, walkway and platform with handrail, stationary center influent column, influent feed well, rotating drive cage, rake arms, sludge collection system, scum skimmer, scum trough, and other appurtenances. Accessory items also covered under this section include energy dissipating system (if applicable), and local control panel.
- C. General Requirements:
  - A. The equipment furnished under this section shall be built by an established manufacturer of wastewater process equipment with at least twenty-five (25) years of successful experience building high quality sludge collecting equipment with at least fifty (50) installations which may be inspected by the Engineer. The clarifier equipment shall be Model COPC1G as manufactured by WesTech (WesTech), Tow-Bro clarifier design and Flocculating Efficiency to Energy Dissipating Well Arrangements (FEDWA) inlet as manufactured by Evoqua Water Technologies (Tow-Bro), or Model HBMS as manufactured by Kusters Water (Kusters). All equipment furnished under this section shall be the product of a single manufacturer.
  - B. If any manufacturer desires approval as an alternate manufacturer or in any way takes exception to, or requests a waiver of certain aspects of this specification, the following requirements apply:
    - A. Manufacturers other than those specified shall submit a complete and detailed EXCEPTION-QUALIFICATION PACKAGE to the Engineer, thru a General Contractor bidding the project, 21 days in advance of the bid to allow an evaluation to determine if approval will be granted by addendum prior to the bid date. This package shall, at minimum, contain the following:
      - 1) A design that is equal to those specified herein in fit, form and function with enough information to show that the alternative will perform at least as well and can be maintained as well as the system specified herein.
      - 2) Detailed Equipment Layout Drawings to scale.
      - 3) Detailed component specifications and catalog cut sheets of all mechanical items.
      - 4) History statement from manufacturer that includes twenty five (25) years of successful experience building high quality sludge collecting equipment with at least fifty (50) installations which may be inspected by the Engineer.
      - 5) History of the equipment offered. History must include all installations in the last 10 years including contact information for each location for confirmation of successful operational and maintenance experience.
      - 6) All other data as required in the Quality Assurance section herein below.

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- B. The Engineer, as the Owners representative, reserves the right to reject an alternate submission that, in their opinion, fails to meet the design intent of the project and/or proposes a substitution that is deemed to be not equal to the specified system.
- C. There shall be no additional costs to the Owner considered for changes or modifications necessary for the installation of an approved alternate. Any and all additional costs including, but not limited to, engineering design, review, excavation, concrete, piping, electrical, etc. shall be borne by the Contractor.
- D. Detailed Requirements: The sizes and capacities of the major items of equipment for each clarifier shall be as follows:

## A. Existing Tank Nominal Dimensions:

- A. Inside Diameter: 110'
- B. Side Water Depth: 15'-0"
- C. Total Wall Height North FST: 17'- 0"
- D. Total Wall Height South FST: 19'-0"
- E. Floor Slope: 1/16:12
- F. Influent Feed Pipe: 42" dia.
- G. Return Activated Sludge Pipe: 20" dia.

## B. Equipment Dimensions:

Equipment	WesTech	Kusters	Tow-Bro
Center Pier Column	42" dia.	42" dia.	42" dia.
Influent Feed Well	31'-0" dia. x 6'-0" deep	29'-0" dia. x 7'-6" deep	24'-6" dia. x 6'-0" deep
Energy Dissipating Inlet Well	10'-0 dia. x 3'-6 deep	10'-0" dia. x 3'-0" deep	N/A
FEDWA Baffles	N/A	N/A	(3) vertical target baffles
Sludge Rake Arms	4'-0" Wide x 4'-0" High Box Truss with Spiral Blades	4'-2" Triangular Truss	5'-0" Truss
No. of Rake Arms	(2) total	(2) total	(2) total
No. of Scum Skimmers	(2) total	(2) total	(2) total
Scum Trough	5'-0 wide with Flushing Valve	4'-0" wide x 4'-9" long with Autoflush Valve	6'-0" wide with Flushing Device
Sludge Collection System	20'-0 dia. x 8" deep Sludge Withdrawal Ring	Sludge headers to rotating 6'-6" dia. x 3'-0" deep sludge manifold	Unitube Headers to 6'-4" dia. sludge collection manifold
AGMA Rated Torque	45,500 ft-lbs	25,000 ft-lbs	21,900 ft-lbs
Motor Shut-Off Torque	54,600 ft-lbs	32,500 ft-lbs	26,280 ft-lbs
Momentary Peak Torque	54,600 ft-lbs	50,000 ft-lbs	43,800 ft-lbs

1.02 – SUBMITTALS

- A. Shop Drawings: All equipment and materials shall be new and shall be specially designed or selected for the function and service specified. Equipment or materials may be used in the project only after the review of shop drawings, specifications, and data as required below:
- A. Shop drawings complete with all dimensions, anchor locations, openings required in structures, details of connecting piping, and the size and location of any required electrical conduits and conduit openings.
  - B. Complete bill of materials for the equipment.
  - C. Specifications for the main center drive unit, the torque monitor, all mechanical and electrical components, and complete wiring diagrams for all electrical equipment.
  - D. Details of the major fabricated components showing the arrangement of devices and labeled with member sizes and materials of construction.
  - E. Calculations documenting the AGMA rating of the drive unit and life of the main bearing preparing and signed by a registered professional engineer.
  - F. Structural calculations by a licensed Professional Engineer for the walkway and platform, center influent column, rotating drive cage, and rake arms.
  - G. Sludge transport calculations substantiating the rake blade design, rake tip speed, and floor slope.
  - H. Complete process calculations substantiating the sizing of the center column and ports, Energy Dissipating Inlets (EDI) and outlets (if applicable), and outer feedwell. These calculations shall be based on parameters from the manufacturers operating experience. These parameters shall be verified by data presented from successful operating installations. Side by side comparison testing of EDI and feedwell design from existing operating clarifiers that have spiral rake blades and are products of the manufacturer shall be presented with the calculations.
  - I. Calculations showing withdrawal rates and headlosses of the sludge collection system.
  - J. Manufacturers recommended procedures for jobsite equipment storage and handling.
  - K. Manufacturer's recommended spare parts.
  - L. Installation list with at least twenty five (25) installations that duplicate the detailed requirements in 1.01D of equal diameter or larger.
  - M. Hydraulic calculations shall be provided for Tow-Bro FEDWA Flocculation Baffles showing dimensional characteristics, port area, velocity, headloss, and mixing intensity.
  - N. WesTech Sludge Withdrawal Ring Data – The submittal shall include data from side-by-side tests on identical full-scale operating clarifiers at least 80 feet in diameter, with identical feed and underflow rates. The data shall show that installation of a sludge collection ring equivalent in design to that proposed for this project produced an average sludge blanket depth approximately one foot lower than a clarifier with only a conventional central sludge hopper.

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- O. Kusters Sludge Collection Header inlet orifices - Detailed calculations shall be submitted to show the velocities, the tank area served by each orifice, the respective orifice size, as well as the velocity through the orifice at maximum and minimum RAS flows.
- P. Sketches and calculations shall be submitted illustrating how the torque will be applied prior to the field torque test taking place.
- B. Operation and Maintenance Manuals: Prior to delivery of equipment and up-dated as required during installation of the equipment, submit manufacturer's complete and detailed installation, operation, and maintenance manuals which shall include the following information as a minimum:
  - A. Name, address, and phone number of nearest competent service organization who can supply parts and service. If this is not the Manufacturer's own service department, then furnish letter confirming that the named organization has been factory authorized to represent the manufacturer of the equipment furnished.
  - B. Complete descriptive literature and drawings of all material furnished. This is to include "as built" wiring diagrams of all electrical equipment, "as built" erection drawings providing up to date information on the actual construction of the equipment furnished, and any field modifications made during installation, start up, and testing.
  - C. Installation, operation, and maintenance brochures from the original manufacturers of all mechanical components such as gear reducers drive couplings, etc., incorporated into the completed installation.
  - D. Recommended spare parts list.
  - E. Drive motor and gear reducer guide to "trouble shooting".
  - F. All required assembly, installation, alignment, adjustment, and checking instructions.
  - G. All required operating instructions.
  - H. All required maintenance instructions including schedules of routine maintenance and lubrication checks.

### 1.03 – QUALITY ASSURANCE

- A. Standardization: All mechanism components, including the center influent column, walkway, center drive unit and torque control drive service platform, influent feed well, rotating drive cage, rake arms, sludge collection system, scum skimmer, scum trough, and drive controls shall be the product of a single manufacturer.
- B. Coordination: The contract documents provide details of a complete equipment installation for the purpose specified. It shall be the Contractor's responsibility to coordinate all the details required for a complete operating system such as protective coating and electrical requirements, as well as provide all work needed to properly install, adjust, and place in operation a complete working system.
- C. Manufacturer's Quality Control: All fabrication shall be carefully inspected at the site of fabrication by factory inspectors who shall use whatever means necessary to assure the proper fit of all field connections and compliance with all material and fabrication requirements of the specifications.

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### 1.04 – PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Preparation for Shipment: All pieces shall be delivered in the largest assemblies practical for field assembly by the Contractor. Individual pieces shall be tagged with erection marks or tags cross referenced with information on the manufacturer's erection and assembly drawings. Gear boxes, mechanical, and electrical components shall be protected from the weather and suitably packaged to facilitate handling and storage. Special lubricating and rust preventative oils shall be provided to prevent internal corrosion of gear assemblies. All mechanical equipment shall be kept dry at all times and shall be stored indoors.
- B. Storage of Equipment:
- A. All equipment stored on the job shall be protected and maintained in accordance with the manufacturer's recommendations.
- B. Electrical equipment shall be stored in weatherproof, well ventilated enclosures.
- C. Structural materials may be stored outdoors on pallets or other wooden supports providing for the proper support, ventilation and drainage. Equipment shall not be allowed to contact the ground directly.

### 1.05 – WARRANTY

- A. Submit a Warranty Certificate typed on company letterhead and signed by an authorized officer of the manufacturer. The certificate shall be witnessed by a notary public in the state where the company headquarters is located. The Warranty Certificate shall be submitted, verbatim and without exception, as follows:

“(Name of manufacturer) guarantees all components of the system to be free from defects in design, materials and workmanship for a period of five (5) years commencing on the date the system was permanently placed on-line, and the mechanical equipment functions without flaw.

During the guarantee period, if any part or equipment component is defective or fails to perform when operating at design conditions and if the equipment has been installed and is being operated and maintained in accordance with the written instructions we provided, then we shall repair or exchange such defective part (s).

The replacement or repair of parts normally consumed in service shall include lubrication. Only lubrication shall be considered as part of routine maintenance and upkeep and shall not be considered eligible for exchange free of charge under this Warranty.

Agreed upon this \_\_\_\_\_ day

(date)

by \_\_\_\_\_ of

(name of authorized agent)

\_\_\_\_\_, who,  
(name of manufacturer)

by signing this document, affirms that he/she is legally authorized to submit this warranty on behalf of the Supplier.

---

AUTHORIZED SIGNATURE

---

---

DATE

---

NOTARY "

## PART 2 - PRODUCTS

### 2.01 – GENERAL REQUIREMENTS

#### A. Structural Design:

- A. Design loading for the structural analysis of the drive cage, rake arms, and center pier column shall be all dead loading resulting from the non-submerged weight of all rotating equipment, plus a live load equal to 2.25 times the continuous output torque rating of the spur gear drive.
- B. The maximum allowable combined stress in any member at this loading shall not exceed 20,000 psi. Structural design of the mechanism and access bridge, including allowable stresses and slenderness ratios where applicable, shall be in accordance with the American Institute of Steel Construction Specification for Steel Buildings, latest edition.

#### B. Hot Dip Galvanizing: All fabricated carbon steel components of the access bridge, drive service platform, slide plates and scum piping and supports and all wetted components of the mechanism shall be A-36 carbon steel hot-dip galvanized (HDG) after fabrication per ASTM A 123.

- A. All structural components shall be designed and fabricated per ASTM A 143, A 384, and A 385. No field welding on hot-dip galvanized equipment will be permitted.
- B. All welding techniques and sizes shall conform to the latest AWS Standards and shall be performed by qualified welders. All welding shall be a minimum of 3/16" fillets, and shall be the full length on all mating surfaces. Welds shall be free of porosity and cleaned for removal of weld flux and impurities that would prevent adhesion of the molten zinc during the hot dip galvanizing process.
- C. Minor defects in the hot-dip galvanizing coating caused by shipping, handling, or installation shall be repaired after equipment installation. The defects shall be thoroughly cleaned and wire brushed to remove all foreign substances, wiped clean with a suitable solvent, thoroughly dried, and coated with at least 3 mils of a zinc rich compound (supplied by the Contractor) specifically formulated for touch up of galvanizing and conforming to USN Specification MIL P 21035 or USAF Specification MIL P 26915A.

#### C. Stainless Steel Fabrication:

- A. All field connections shall be bolted connections designed to resist all static, live, and erection loads. Field welded assembly will not be allowed. All bolted structural connections shall be gusseted as required to prevent deflection with minimum 3/16" thick steel plate. Main structural connections shall use a minimum of two (2) 5/8" diameter bolts. Secondary structural connections shall use a minimum of two (2) 1/2" diameter bolts.

#### D. Anchorage and Fasteners:



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- A. All structural fasteners (excluding the tie rods) shall be type AISI 18-8 (300 series) stainless steel.
- B. All cast in place equipment anchorage, including nuts and washers shall be of AISI Type 18-8 (300 series) stainless steel. The minimum size of any cast in place anchor shall be 3/4" diameter.
- C. All installed anchors shall be drop in style (hole size equals bolt size), and shall conform to Federal Specifications GSA FF S 325, Group II, Type 4, Class 1. Anchor bolts to be Type 18-8 (300 series) SS with clips, nuts and washers to be Type 18-8 (300 series) stainless steel.

## 2.02 – CLARIFIER EQUIPMENT

### A. Gear Drive Mechanism:

#### A. WesTech

##### A. Design Parameters

- 1) The drive unit shall be designed and manufactured by the clarifier equipment supplier to ensure unit responsibility. The drive unit shall be designed for the torque values previously listed in Section 1.01D.B. The drive unit shall turn the mechanism at the design collector tip speed. The drive main bearing shall be designed for the total rotating mechanism loads with a minimum L 10 life of 50 years or 438,000 hours. The drive unit shall be capable of producing and withstanding the previously listed momentary peak torque while starting. The drive main gear shall be designed to a minimum AGMA 6 rating when rated in accordance with the latest AGMA standard. Gear teeth shall be designed for proper load distribution and sharing. Stub tooth design and surface hardening of the main gear shall not be allowed. The main bearing shall be capable of withstanding an overturning moment of 450,000 ft-lbs without the aid of any underwater guides or bearings to ensure correct tooth contact for AGMA rating of the main gear.
  - i. All spur gearing shall be designed to the latest AGMA spur gear standard for strength and surface durability, based on a life of 175,000 hours. The design running torque rating of the drive gearing shall be based on the smaller of the strength and durability values determined from the above AGMA standard. To ensure safety and ease of maintenance, all components of the drive shall be direct coupled.
  - ii. No overhung pinions shall be allowed on the speed reducing unit. The lower pinion bearing shall not be located below the turntable base.
  - iii. Welding on the drive unit shall be done using E70XX weld rod.

##### B. Physical Characteristics

- 1) The drive unit shall consist of a solid internal main spur gear, bearing turntable, pinion, secondary speed reducer, support base, and drive unit bearing. The drive shall be mounted on the center column and support the entire rotating load of the mechanism. The main internal gear shall be forged of alloy hardened steel. The pinion shall be heat treated alloy steel. Support base for the drive shall be of welded steel to assure rigidity. Dust shields shall be provided. The drive bearing shall include a forged steel precision gear/bearing set, with fully contoured raceways hardened to a minimum 58-62 Rc and protected by a neoprene seal. The drive shall be designed so that the balls and nylon spacers can be replaced without removing the access walkway. The main gear to pinion

gear mesh shall be oil lubricated. An oil sight glass, fill pipe, and drain shall be provided for the reservoir. Lubrication fittings shall be readily accessible.

C. Overload Protection

- 1) An overload device shall be provided in a stainless steel, weatherproof enclosure. The device shall be actuated by torque generated from the main drive, which shall operate two independently adjustable switches (the alarm switch at 100 percent of design running torque and the motor cutout switch at 120 percent of design running torque). Devices that require the worm to float and measure the thrust of the worm gear shall not be acceptable. These two switches shall be factory adjusted to accurately calibrate the alarm torque value and the overload position. A visual torque indicator shall be provided and oriented so that it may be read from the walkway. The indicator shall be calibrated from 0 to 160 percent of design running torque.

D. Turntable

- 1) The turntable base shall have an annular bearing raceway upon which the rotating assembly rests. It shall have a maximum allowable deflection in accordance with the bearing specifications. The allowable modulus of elasticity shall be a minimum of  $29 \times 10^6$  psi. The center cage shall be fastened to and supported from the gear casing. Ball bearings shall be of high carbon chrome alloy 52100 steel running in fully contoured races, as part of a precision gear/bearing set. The balls shall be grease lubricated and protected by elastomer seals. Felt seals that allow the entrance of moisture from outside the drive (i.e. rain water, condensate, etc.) will not be allowed.

E. Speed Reducing Unit

- 1) The speed reducing unit shall consist of cycloidal, helical, or planetary speed reducers directly connected to a motor without the use of chains or v belts, and shall be keyed to the pinion.
  - i. The main ring gear of cycloidal drives shall be made of high carbon chromium bearing steel and be fixed to the drive casing. An eccentric bearing on the high speed shaft shall roll cycloidal discs of the same material around the internal circumference of this main ring gear. The lobes of the cycloid disc shall engage successively with pins in the fixed ring gear. The movement of the cycloid discs shall be transmitted then by pins to the low speed shaft. Speed reducer efficiency shall be a minimum of 90% per reduction stage.
  - ii. Speed reducer helical or planetary gearing shall be manufactured to AGMA standards and shall provide at least 95% power transmission efficiency per stage. The speed reducer shall have a minimum service factor of 1.25 based on the output torque rating of the drive.
  - iii. The reducers shall be fitted with radial and thrust bearings of proper size for all mechanism loads and be grease lubricated. As a safety feature, the speed reducer shall be back drivable to release any stored energy as the result of an over torque condition.

F. Motor

- 1) The motor shall be a squirrel cage, induction type, TEFC, ball bearing heavy duty unit of ample power for starting and operating the mechanism without overload, with a minimum service factor of 1.15.
  - i. Power supply to the equipment shall be 240/480 volt, 60 hertz, 3 phase.

B. Kusters

- a. General: The center clarifier drive mechanism shall consist of an electrical motor, primary reducer, intermediate gear reducer and a main gear set consisting of a spur pinion and internal tooth spur gear.
- b. Motor: The clarifier drive shall be driven by an electric motor. The motor shall be UL rated for the operational environment non-hazardous. The motor shall be rated for 240/ 480V, 60 Hz, 3-phase operation with a minimum service factor of 1.0.
- c. Primary Reducer: A primary hydraulic reducer shall transmit torque to the intermediate reducer and provide overload protection. The hydraulic system shall be self-contained, and fully enclosed in a 304 stainless steel enclosure. The enclosure shall also function as the fluid reservoir and shall provide a minimum 8 gallon capacity. The hydraulic system shall include: a hydraulic motor, a hydraulic pump, an aluminum manifold assembly, a flow directional valve, a pressure relief valve, an oil filter assembly, an oil filter replacement indication gage, a 6-inch diameter glycerin filled torque indication gage and all necessary hoses and fittings.
- d. Intermediate Reducer: The intermediate reducer shall be a planetary type, providing no less than 90% gear efficiency. All lubrication of the planetary gearing shall be oil. Grease lubrication is not permitted. The planetary reducer shall be designed for a 200,000 hr. service life at the rpm and torque specified in Section 1.01D.B. The output shaft of the intermediate reducer shall be keyed to a heat treated spur pinion.
- e. Final Reducer: The main gear shall include an internal tooth spur gear and spur pinion. The main gear material shall be ASTM A536 Ductile iron, 80,000 psi minimum tensile strength. The pinion shall be constructed from AISI 4150 steel, hardened to a minimum 340 Bhn.
- f. Turntable Base: Cast iron, ASTM A48 Class 40 minimum 40,000 psi tensile strength; able to be bolted to center column and to provide support for internal spur gear, the entire rotating collector mechanism and one end of the access bridge. Fabricated steel housing are not permitted.
- g. Main Bearing: The main bearing shall consist of a full complement of hardened steel chrome ball bearings (1" minimum), each riding on four replaceable hardened steel strip liners. Each liner shall be 3/8" x 3/8" square, heat treated to a minimum 48-50 Rc. The bearing liners shall be independently replaceable without the need to remove the clarifier drive, Access Bridge or platform. The main bearing diameter shall be minimum 48 inches.
- h. Torque Overload Protection: The clarifier drive shall include a hydraulic torque overload protection system. Mechanical overload devices are not permitted due to their inherent inaccuracy. Two overload switches shall be provided, one for "alarm" set at 100% of the continuous torque identified in Section 1.01D.B., and one for "motor cut-off" set at 130% of the continuous torque identified in Section 1.01D.B. Additionally a pressure relieve valve shall be provided set at 150% of the continuous torque identified in Section 1.01D.B. All switches shall be current rated for 120 VAC. Each switch shall be NEMA rated for the specified non-hazardous environment. The torque indication gage shall be 6 inches in diameter, glycerin filled with a scale that displays actual operating torque (ft-lbs or N-m).

- i. Condensate Removal: A condensate removal system shall be included to automatically remove condensate from the main gear housing. The condensate system shall include a 1" galvanized steel piping with vertical stem. The pipe arrangement shall be designed to provide constant removal of condensate from the main gear housing. A minimum of 6" clearance shall be provided below the low point drain to allow for easy access by plant personnel.
- j. Coatings: Each clarifier drive mechanism shall be factory coated with 2 coats (2-3 mils per coat, minimum DFT) of Tnemec epoxy prior to shipment.

C. Tow-Bro

A. General

- 1) Drive mechanism consisting of primary helical gear reduction, intermediate worm gear reduction unit and enclosed final reduction unit consisting of internal spur gear and pinion in a turntable base is to be completely assembled and finish painted in the manufacturer's shop.
- 2) All gearing shall be enclosed in gray cast iron ASTM A-48 Class 40B housings. Fabricated steel housings, exposed gearing and submerged bearings will not be acceptable.
- 3) The drive shall be designed to allow removal and replacement of internal gear, balls and strip liners without raising the walkway.
- 4) All components of the drive mechanism shall be designed in accordance with AGMA Standard 6034-B92 "Practice for Enclosed Cylindrical Worm Gear Speed Reducers and Gearmotors", and Standard 2001-D04 "Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth"; for 24-hour continuous, uniform load duty and 20-year design gear life at the specified output speed. The AGMA rated torque of the drive shall be the lowest value computed for worm gear set, spur gear and pinion for strength and durability.
- 5) Select conservative values for bending strength and pitting resistance life factors KI and CI based on a minimum of 420,000 cycles of the main gear. The drive AGMA torque rating shall be as specified above with a minimum 1.25 service factor.
- 6) All bearings shall be designed for a minimum B-10 life of 200,000 hours.

B. Primary Reduction Unit

- 1) Provide commercially available helical gear reducer or gearmotor in a cast housing.
- 2) All bearings shall be anti-friction type running in oil.
- 3) Motor shall be totally enclosed, ball bearing type, of ample power for starting and continuously operating the drive mechanism without overloading.
- 4) Motor to conform to NEMA standards and be suitable for operation on 230/460 volt, 3 phase, 60 Hertz current with a service factor of 1.25.
- 5) Primary reduction unit shall drive the intermediate reduction through a chain and sprocket arrangement with #80L self-lubricating chain and non-corrosive OSHA compliant removable chain guard.
- 6) Provide proper chain tension by an adjustable steel base mounted on the intermediate reduction unit.

C. Intermediate Reduction Unit

- 1) Provide worm gear speed reduction with grease and oil lubricated anti-friction type bearings in cast iron housing securely bolted on the machined top face of the final reduction unit. Worm and shaft shall be a two-piece assembly for ease of maintenance. Cycloidal and planetary gearing will not be acceptable.

- 2) Align and maintain accurate centers with the final reduction gearing. Swivel base mounting of the intermediate unit will not be acceptable.
- 3) Mount an electro-mechanical overload device on the thrust end of the worm shaft consisting of plate spring assembly, plunger, indicator dial two (2) micro-switches (one N.O. and one N.C.) and a terminal block, all enclosed in a weather tight, gray cast iron housing. Amperage metering devices will not be considered equal to the overload device specified.
- 4) Micro-switches shall be factory set to: (1) sound an alarm when the load on the mechanism reaches 100% of the AGMA torque; and (2) stop the motor when the load reaches 120% of the AGMA torque.
- 5) Provide a shear pin device mounted on the drive end of the worm shaft.

D. Final Reduction

- 1) Provide internal, full depth involute tooth design, ductile iron spur gear driven by a heat treated steel pinion from the slow speed shaft of the intermediate reduction unit. Stub tooth design will not be acceptable.
- 2) Provide bearings at top and bottom of pinion to ensure complete tooth contact between mating surfaces. Pinion and pinion shaft shall be furnished as a two-piece assembly for ease of maintenance.
- 3) Provide cast iron turntable base with annular raceway to contain balls upon which the internal gear rotates. The ball race shall ensure low unit ball load, long life and stability without the use of submerged guide shoes, bumpers or steady bearings.
- 4) Provide four (4) 3/8" thick x 3/4" wide renewable special hardened (38-42 Rockwell C) steel liner strips force fitted (pins and cap screws not permitted) into the turntable base and internal gear for balls to bear on vertically and horizontally.
- 5) Provide an internal gear of split design with precision mating surfaces for ease of removal of gear, balls and liner strips without raising bridge. Drives without this feature are not acceptable.
- 6) Internal gear, pinion and balls to run in an oil bath and be protected by a felt seal and vertical neoprene dust shield.
- 7) Provide oil filling and level pipe along with a drain plug and sight gauge.
- 8) Turntable base shall be bolted to the center column and be designed to support the bridge, internal gear and rotating mechanism.

B. Drive Control Panel: The Manufacturer of the sludge collector equipment shall provide a local drive control panel mounted to the drive service platform handrail of the mechanism. The interconnecting wiring and conduit shall be provided by the Contractor. The control panel shall be furnished completely pre-wired and tested, requiring only mounting and connection to field mounted electrical devices.

A. The drive control panel shall include a NEMA Size 1 combination starter with 3 leg thermal overload protection and external reset and a circuit breaker with flange mounted visible lockable disconnect switch within a NEMA 4X stainless steel oversized enclosure. All hinges and latches shall be corrosion resistant. Additional devices mounted within the enclosure shall include: a fused 0.5 KVA control power transformer; overload relay, pending overload relay, and alarm silence relay; and, terminal strips for connecting the overload and alarm contacts located in the drive torque monitor.

A. External controls shall be weatherproof NEMA 4X corrosion resistant and shall include: local/off/remote switch, illuminated run light, torque alarm light, torque motor cutout light, alarm silence push-button, overload reset push-buttons and main power disconnect. A weatherproof combination horn and light fixture with 10 watt LED bulb shall be mounted to the top of the enclosure. A door mounted reset pushbutton shall be provided that clears all interlocks after the high torque conditions have been removed.

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- 1) Pilot devices shall be mounted on the enclosure front panel door.
  - 2) Indicator lights shall be LED type. Selector switches shall be heavy duty NEMA type.
- B. The control power transformer shall be included to provide 120 VAC for internal controls. The transformer shall have both primary legs and one secondary leg fused.
- B. Control Panel Electrical Power: 460 volt, 3-phase, 60 hertz. A 3 pole molded case circuit breaker with pad-lockable disconnect handle shall be provided for short circuit protection.
- C. Center Pier Column: Provide a circular steel center pier that serves as the influent pipe. The top of the center pier shall provide a stable and accurate surface upon which the main gear may be mounted. The center pier shall support the main gear, access truss bridge, drive service platform, and the entire weight of the rotating mechanism.
- A. The center pier shall be constructed of minimum ¼" thick A36 carbon steel plate or pipe. The pier shall be provided with minimum 1" thick steel plate top and bottom flanges. The top flange shall have mounting holes matching the main spur gear drive. The bottom flange shall be provided for mounting to the concrete floor.
- A. The equipment manufacturer shall provide eight (8) 1" dia. x 15" long type 304 stainless steel all thread rods with nuts / washers and epoxy capsules for center column anchorage.
- B. Prior to the center column being grouted in place, the drive unit shall be installed, positioned, and leveled.
- D. Influent Feed Well: Clarifier influent shall pass through an influent feed well
- A. The influent well shall be fabricated with 3/16" thick steel plate, supported by structural channels attached to the drive cage using minimum 3/4" diameter fasteners.
- B. The influent well shall be supported by and rotate with the drive cage frame. Four (4) 10" deep steel channels shall be provided to support the inlet well.
- C. Top edge shall be approximately 4" above tank water surface.
- D. Provide baffled slots at liquid level to permit removal of floating material in well; 12" long' extending 2" below low-water level. Slots shall be baffled to prevent short circuiting to the weirs.
- E. Energy Dissipating Inlet (EDI) Well (WesTech and Kusters)
- A. Mounted concentric with center column, supported by center cage; top edge approximately 6 inches above water surface; designed to diffuse influent into tank to greatest extent possible. Closed and sealed bottom within 1 inch of center column.
- B. The EDI well shall be equipped with multiple curved outlet ports located on the side of the well. The ports shall be arranged evenly around the EDI and shall discharge the liquid into the direction of rotation to further dissipate energy and enhance flocculation. Dual gates creating impinged flow shall also be acceptable.
- C. The EDI shall be made of not less than 3/16 inch thick steel plate with necessary stiffening angles.

F. FEDWA Flocculation Baffles (Tow-Bro)

- A. Provide inlet baffles to promote effective mixing and tapered flocculation.
- B. Flow shall impinge three (3) overlapping vertical target baffles in secession with a series of four (4) impingement zones.
- C. Design to provide a "Gt" (t in seconds) value in the well not exceeding 6,000 with a velocity gradient "G" within the well of at least 35 fps/ft and not exceeding 60 fps/ft at a minimum water temperature of 10 degrees-C at peak influent flow.
- D. Provide horizontal shelf baffles to prevent downward movement in flocculation zone.
- E. Baffles shall bolt to center cage and well support beams.
- F. Fabricate baffles from minimum 3/16" thick A36 carbon steel plate.
- G. Los Angeles Energy Dissipating Inlet (LA EDI) system shall be the only acceptable alternative to the FEDWA design.

G. Drive Cage Frame: A center rotating drive cage frame shall be furnished to provide an attachment structure for the sludge rake arms and feedwell supports. The cage top shall be bolted to the main gear which shall rotate the cage with the attached arms and feedwell. The drive cage shall be completely supported and stabilized by the main gear bearing. No water supports, bearings, or bumpers will be allowed.

- A. Fabricate drive cage from minimum 1/4" thick A36 carbon steel plate and shapes, be shop welded and for field bolted connections.
- B. The drive cage shall be designed as a box truss for the load conditions described in Section 2.01 A.

H. Sludge Rake Arms: The sludge collector mechanism shall have two (2) collector rake arm frames to sweep the floor twice each revolution and a hydraulic differential sludge removal system designed for high rate sludge return and concurrent skimming the clarifier surface between the influent well and the scum baffle. Sludge rake arms shall convey settled sludge to the sludge collection system. The rake speed shall be sufficient to transport the necessary volume of sludge to the sludge outlet but shall not re-suspend settled sludge. Rake arms shall be pinned at the base for vertical adjustment and connected to the center cage through strut and adjustable clevis assembly. Tie-rod and turnbuckle designs that do not provide lateral support will not be acceptable.

I. Sludge Collection System

A. WesTech – Sludge Withdrawal Ring

- A. The tank floor slope and sludge withdrawal ring design shall be verified by the clarifier equipment manufacturer and contractor. The sludge withdrawal ring shall be located and sized to prevent short-circuiting of the influent to the underflow. Place ring at a point of high sludge concentration. It shall be rectangular in cross section and shall remove sludge uniformly around the center of the tank.

- 1) The sludge withdrawal ring shall surround the center column and shall include appropriate anchorage to the tank floor. The cross section shall be tapered along its length to assure a constant sludge velocity through

the ring. Equally spaced orifices shall be cut into the outer ring wall. The orifices shall be sized to avoid plugging. The outer ring wall shall be at a constant radius. The annulus between the column and the ring shall be filled with grout.

B. Kusters – Sludge Manifold and Collection Header

- a. Each collector shall be provided with a fabricated steel rotating sludge manifold that is rigidly attached to the lower end of the drive cage. The manifold shall encompass the influent pier and be provided with upper and lower seals to limit the passage of fluid between the manifold and pier. The bottom of the manifold shall be hollow and completely cover the sludge withdrawal opening while riding on a full diameter seal ring and mounting plate assembly
- b. To assure uniform sludge draw off, a galvanized steel header assembly shall be provided that will consist of a tapered tube section that varies in size from a maximum near the tank center to a minimum at its outer end. The longitudinal cross-sectional axis of the header shall be mounted at an angle of 45 degrees with the tank bottom. The leading edge of the header shall extend forward and down 2 inches at an angle of 45 degrees to provide an equalizing vane as an integral part of the header and to direct the sludge into the orifice's area of influence. A flange shall be provided at the inner end of each header for connecting the fabricated steel center outlet manifold. The header shall be supported using the truss arm and/ or stainless steel tie-rods.
- c. Inlet orifices shall be spaced at regular intervals along the length of the header. The orifices shall vary in size from a minimum near the tank center to a maximum at the outer end and shall be accurately located. The orifices shall be designed to withdraw sludge volumes proportional to their respectively swept areas of the tank at all flows.
- d. Two headers shall be provided, one under each truss arm. The headers shall be rigidity supported by each truss arm, the use of tie rod supports only will not be permitted.

C. Tow-Bro – Sludge Manifold and Unitube Collection Header

- A. Provide a cylindrical sludge manifold with two (2) seals for bolted connection to the sludge collection header and bottom of cage. A bottom seal plate shall be furnished by the equipment manufacturer for securely anchoring to the floor and grouting in place after final adjustment.

B. Sludge Collection Header

- 1) The header shall be parallel to the tank floor and have a series of inlet orifices such that the entire tank bottom is swept clean in a single revolution.
- 2) The header shall be designed to uniformly remove sludge in proportion to the area swept with the removal of a larger volume of sludge at greater distances from the tank center.
- 3) Sludge shall be transported through the header to the center manifold, with removal being accomplished by hydrostatic pressure.



- 4) Provide a fully tapered, rectangular-shaped Unitube header varying in cross section from a maximum near the tank center to a minimum at the outer wall.
- 5) Fabricate header from 1/4" thick steel plate.
- 6) Provide steel plate counterweights not exceeding 50# each as necessary for proper equipment balance. Field welding of galvanized header or supports will not be allowed.
- 7) Longitudinal cross sectional axis to be mounted at an angle of 45 degrees to tank bottom to trap sludge.
- 8) Provide a 2" fluidizing vane as an integral part of header. Attach neoprene squeegee to fluidizing vane provided with 1" vertical adjustment.
- 9) Manufacturer to size and space header inlet orifices at regular intervals not exceeding 30".
- 10) Orifice design to be proportionate to the volume of sludge withdrawn from the entire tank floor at all flows.
- 11) Provide header flange with silicone seal for bolted connection to center manifold. Provide an all welded steel truss arm for header support.
- 12) Sludge withdrawal by means of individual riser pipes or stepped header construction will not be acceptable.

J. Scum Collection System:

- A. Provide skimmer system consisting of skimming arms and hinged wiper assembly.
  - A. Skimming arms shall span the full length between the influent feedwell and scum trough. Skimming arms shall have a height of 5-in rigidly attached to vertical pipe supports and extending from the rake arms. The skimming arms shall rotate with the truss arms.
  - B. Mount a hinged wiper assembly on the end of the skimming arm to form a pocket for trapping scum. The wiper assembly shall maintain continual contact and proper alignment between scum blade, outer scum baffle and scum trough. The wiper blade shall have a wearing strip on its outer end which contacts the scum baffle and neoprene strip on its inner and lower edges which contact the scum trough.
  - C. All springs, pivot points and threaded fasteners shall be constructed of 302 stainless steel. The hinged wiper assembly shall be hot dipped galvanized. The wiper blade shall be neoprene with a minimum of ¼ inch thickness and Durometer range 50-60. The wiper assembly shall be the same dimension of the scum trough.
  - D. Provide a manual lockout mechanism on hinged skimmer assembly to allow for flexible independent operation for surface ice. Lockout mechanism shall raise hinged skimmer assembly above water surface without removal.
- B. Provide one scum trough of ¼ inch welded steel plate supported from the tank wall and connected to the scum withdrawal piping.

## 11335 – SEDIMENTATION TANK EQUIPMENT

- A. Scum trough shall be adjacent to the scum baffle consisting of vertical steel sides, a sloping approach ramp and 6" discharge pipe. A flexible connector shall be provided for connection to the contractor supplied scum withdrawal piping in the tank wall.
- B. The ramp shall extend from 1-1/2 inches above water level to 5-1/2 below water level. A similar ramp shall be provided at the opposite end to allow the skimmer blade to lower back to the operating position.
- C. Provide a counterweighted flushing device attached to the scum trough actuated by the main tank skimmer arm. Actuator arm shall pivot on a 3/4" minimum diameter stainless steel pin riding in an oil impregnated sintered bronze bushing. The actuator arm shall be counterweighted by steel plates to assure positive valve closure. The opening and closing of the scum flushing valve shall be one smooth continuous movement. The flapper valve shall be held open to allow 15 to 20 gallons of flushing water per trip.
- K. Access Bridge / Service Platform: A fixed access truss bridge and drive service platform shall be furnished to provide access to the center drive assembly. The bridge shall span the full clarifier tank diameter and shall be supported at the tank walls and the main spur gear drive assembly.
  - A. The bridge shall consist of fabricated steel wide flange beams interlaced with cross angles and diagonal angles for rigidity. Structurally, the bridge shall be designed such that the maximum deflection shall be limited to 1/800 of the span, with all dead loads plus a live load of 50 lbs./sq. ft. on the walkway. The Manufacturer shall be responsible for sizing the members to meet these requirements; except, that the members specified are the minimum acceptable.
  - B. Two (2) slide plates shall be provided at each of the clarifier side walls to allow for thermal expansion. The slide plates shall be a minimum of 1/2" thick carbon steel plate.
  - C. The bridge shall be provided with a minimum 36" wide walkway designed to allow for an uninterrupted passage along its entire length across the clarifier basin. The access walkway shall consist of removable hot-dip galvanized carbon steel grating sections; 1 1/4" deep x 3/16" x 1" clear openings.
  - D. A drive service platform shall be provided to allow easy maintenance of the gear drive assembly. The platform shall provide 24" clearance outside the center drive components. Platform to be covered with removable 1/4" thick aluminum checkered floor plate.
    - A. The access bridge and service platform to include an anodized aluminum handrail / kickplate system provided for all sides assembled from 1 1/2" dia. schedule 40 aluminum pipe (if the access bridge is a fabricated truss the handrail is part of the truss). The railing shall be a two (2) rail system with the top rail located at 42" above the deck and include a 4" wide extruded aluminum kickplate. The handrail system shall be pre Golden Rail or equal and comply with all current OSHA standards.
- L. Accessories
  - A. Weir Cleaning System
    - A. Capable of being attached to the skimmer arm without impeding the clarifier operations.
    - B. Shall clean the baffle plate and effluent launder weir of accumulated algae and debris.

## 11335 – SEDIMENTATION TANK EQUIPMENT

### C. Manufacturers:

- 1) Clarifier CleanSweep by Innovative Treatment Products, Inc.
- 2) Weir-Wolf Clarifier Brush Cleaning System by Ford-Hall
- 3) Or equal

M. Lubrication: Lubricants of the type recommended by the equipment manufacturer shall be furnished and applied by the Contractor. The Contractor shall certify that the collector drive system has received the proper amount of recommended lubricant.

N. Manufacturer's Service Representative: A trained field service technician employed by the equipment manufacturer shall inspect the equipment installation and direct the contractor to make adjustments necessary to ensure the clarifier is installed per manufacturer's requirements. A service the representative shall provide is to check the mechanisms for level prior to grouting the floor. Service time shall be 1 day of inspection prior to grouting the floor including observation of torque testing, 1 day post-grout inspection with startup and a general training seminar, and one additional day for operation assistance of the equipment supplied for a total of 2 trips and 3 days on site, excluding travel to the site, for each clarifier.

### O. Surface Preparation and Finishing:

- A. The center drive mechanism shall be shipped, assembled and finish painted with manufacturer's standard paint system.
- B. Submerged components will be prepared by blasting to SSPC-SP6 and prime painted with one (1) shop coat. Finish coats shall be applied in the field by the Contractor.
- C. Non-submerged components will be prepared by blasting to SSPC-SP10 and prime painted with one (1) shop coat. Finish coats shall be applied in the field by the Contractor.
- D. Galvanized and stainless-steel components shall not be painted.

### P. Spare Parts

- A. Two (2) skimmer wipers for each clarifier
- B. Two (2) neoprene squeegees for each clarifier
- C. One (1) drive seals and bearings for each clarifier
- D. Two (2) Hydraulic Oil Filters per clarifier (Kusters only)
- E. Manufacturer recommended oil and lubricants required for one year of operation for each clarifier
- F. Two (2) Gear Drive Units with Motors

## PART 3 – EXECUTION

### 3.01 – INSTALLATION

- A. Verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Notify Engineer of significant deviations.

## 11335 – SEDIMENTATION TANK EQUIPMENT

- B. Installation of the equipment shall be in strict accordance with the contract documents and the Manufacturer's instructions and shop drawings. Manufacturer shall supply anchor bolts for the equipment. Contractors shall install the anchor bolts in accordance with the Manufacturer's recommendations.
- C. Furnish over the course of the Contract the services of the manufacturer's factory-trained technician for twenty-four (24) trips and thirty-six (36) days for installation inspection services, start-up, commissioning, and operator training.
- D. Equipment shall not be energized, or "bumped", to check the electrical connection for motor rotation without installation inspection and the manufacturer's service technician present.
- E. The equipment manufacturer's service technician shall test rotate each clarifier for 2 complete revolutions at design operating speed, inspect the installation, and make recommendations for any necessary mechanical adjustments by the Contractor.
- F. The equipment manufacturer's service technician shall conduct a torque test during the start-up and commissioning to demonstrate proper operation of the overload system.

### 3.02 – FIELD TESTS AND INSPECTIONS

#### A. Torque Tests

- A. The entire sludge collector mechanism shall be statically load tested by loading the rake arm with 150 percent of the specified design running torque. The test shall verify the torque overload control device settings for alarm and motor cutout. One truss arm shall be anchored and the load measured to demonstrate the rake arms', cage's, and drive unit's ability to withstand the specified torque.

#### B. Operation Tests

- A. Operate the mechanism in a dry tank for a minimum of 4 continuous hours before flow is allowed to enter the system. There shall be no binding, jerky, or unusual motion exhibited during this run-in period. Motor amperage shall be measured and recorded at start and every subsequent hour for any unusual or higher than normal values. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 4-hour observation test run. If the unit should fail under any of these conditions, the test shall be halted and the problem corrected. If, after several attempts, the unit does not successfully pass the field test, the faulty portion of the equipment shall be repaired or replaced, the tank emptied and the operation test re-run.

### 3.03 – MANUFACTURER'S SERVICES

- A. Technical Representative: Furnish the services of trained manufacturer technical representatives as needed to provide for a satisfactorily operating system. Services to include are as follows:
  - A. Prior to equipment delivery, submit a minimum of four (4) paper copy sets and two (2) flash drives with the documents in searchable .pdf format of complete installation, operation, and maintenance manuals which shall include assembly / erection drawings, as built drawings of electrical equipment, parts lists, and detailed written instructions for the installation, operation, and maintenance of the equipment furnished.

## 11335 – SEDIMENTATION TANK EQUIPMENT

- B. Not less than two (2) days (per tank) on the job site for inspection of the completed equipment installation, final inspection, final leveling, alignment, tensioning, lubrication of the installed equipment, and a detailed check of the completed work prior to start up.
  - C. Deviations from the Manufacturer's written or verbal instructions shall be subject to approval by the Engineer and discrepancies or unsatisfactory work shall be reported in writing by the equipment manufacturer's representative jointly to the Engineer and Contractor.
  - D. Not less than one (1) day (per tank) on the job site for operation assistance.
- B. Certification: Within ten (10) days after the final inspection of the completed installation in each tank, the manufacturer's representative shall submit a detailed report jointly to the Engineer and Contractor which shall list deficiencies found in the work and a recommended corrective action for each deficiency. Upon completion of any corrective action required, the Manufacturer shall furnish a letter certifying that the equipment is now properly installed and ready for the operation and beneficial use by the Owner.

END OF SECTION 11335

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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, 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. Field-mounted instruments and devices.
  - b. Programmable logic controllers (PLC) and licensed software.
  - c. Operator Interface Terminal (OIT) and licensed software.
  - d. Programming and configuration of the PLCs and OITs.
  - e. Uninterruptible power supply.

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.

D. Coordination:

1. Process Controls:
  - a. 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 OIT software is part of the Work. The I&C Supplier's programmer shall program and configure the software. Functional description of process system and associated equipment is included in Section 13491, Process Control Descriptions.
  - b. 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.
  - c. 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 I&C Supplier programmer. Provide Work for Contractor-furnished control options not on the input/output list at no additional cost to Owner.
2. To centralize responsibility, I&C materials and equipment provided under this Contract shall be furnished by a single Supplier.

## 13401 - PROCESS CONTROL SYSTEM GENERAL PROVISIONS

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 I&C materials and equipment from a single manufacturer.
5. Supplier's Responsibilities:
  - a. Preparing all process control equipment submittals in accordance with the Contract Documents.
  - b. 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.
  - c. 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.
  - d. Direct, detailed oversight of installation of instruments, panels, consoles, 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.

### 1.02 – RELATED SECTIONS

- A. Section 13403 – Process Control System Start-up and Field Testing
- B. Section 13404 – Process Control System Training
- C. Section 13420 – Primary Sensors and Field Instruments
- D. Section 13430 – Process Control Panels and Enclosures
- E. Section 13440 – Panel Mounted Instruments and Devices
- F. Section 13451 – PLC Hardware and Software
- G. Section 13480 – Input Output Point List
- H. Section 13491 – Process Control Descriptions

### 1.03 – REFERENCES

- A. Standards referenced in this Section are:



## 13401 - PROCESS CONTROL SYSTEM GENERAL PROVISIONS

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.

### 1.04 – 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 or utilize a 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.
- 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 project site unless otherwise acceptable to Owner.
  - 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 the Project. List shall include I&C Supplier project manager, project engineer, field representative, local service representative, and sales representative(s). Indicate work 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.

#### 1.05 – 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 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:
      - i. Input/output (I/O) point listing with I/O module cross-reference identification.
      - ii. I/O module cross-reference identification based on I/O address list developed by I&C Subcontractor .
    - h) Database listing, including all I/O points.
      - i. 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.
- e. 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 to 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 1.04 of this section.
  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 OIT screens.
- 3. PLC Programming and SCADA Integration
  - a. Machine Readable Documentation. The supplier shall provide two sets of documented unprotected as-built Electronic PLC, PC, OIT and all other required software files on portable digital media in native machine readable format, final software programs and any passwords or hardware/software required to modify or restore all programs and configurations developed under this Contract. This machine readable documentation shall include all documentation files including logic and annotation files. All changed made during or after factory acceptance tests shall be incorporated at no additional cost to the Owner. Supply of these items shall not require any ongoing support contract or long-term relationship with the supplier.
  - b. Submit a memory map of PLC registers for use by the SCADA system programmer no later than 30 days prior to the scheduled shipment of the equipment to the site. Provide a list of all system registers displayed on the control panels provided under this contract OIT's so that control and monitoring of statuses can be replicated on the plant's existing HMI by the SCADA system programmer. The list of registers shall include a register tagname, description, type, range and engineering units/state descriptions. If any security parameters are required, indicate such on the list (i.e. operator, supervisor, administrator).
  - c. Control panel supplier shall contact and coordinate with the SCADA system programmer to ensure compatible configuration of the manufacturer-supplied PLCs in order to match the facility network. Control panel supplier shall configure the network addresses in their equipment to match the addresses provided by the SCADA system programmer.
- 4. 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.
- 5. Source Quality Control Submittals:
  - a. Results of factory testing.
- 6. 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.

7. Field Quality Control Submittals:
    - a. Submit the following prior to commencing system checkout and start-up.
      - 1) Completed calibration sheets for each installed instrument showing five-point calibration (zero, 25, 50, 75, 100 percent of span), signed by factory-authorized service technician.
    - b. Field calibration reports
    - c. Field testing reports.
  8. 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.
  9. Qualifications Statements:
    - a. I&C Supplier.
    - b. Manufacturers, when required by Engineer.
- 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 outdated 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 outdated 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) 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) One 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.

#### 1.06 – 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

#### 2.01 – 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 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.

## 13401 - PROCESS CONTROL SYSTEM GENERAL PROVISIONS

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 15 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:

## 13401 - PROCESS CONTROL SYSTEM GENERAL PROVISIONS

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 13499 for product requirements for materials and equipment that are part of the PCS.

### PART 3 – EXECUTION

#### 3.01 – PCS – GENERAL PROVISIONS FOR EXECUTION

- A. Refer to Sections 13400 through 13499 for execution requirements for the PCS.

END OF SECTION 13401

## PART 1 - GENERAL

### 1.01 - 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 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.

### 1.02 - SYSTEM CHECKOUT AND START-UP

- A. Contractor, under the supervision of the I&C Supplier, 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 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.

### 1.03 - 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.

#### 1.04 - 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. Aeration Tank Low Pressure Air Pass Control Panels
  - 2. Aeration Tank Low Pressure Air Grid Control Panels
- 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 1.04-E, below:
  - 1. Failure of any of the pumps.
  - 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

F. 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 13403

+ + NO TEXT ON THIS PAGE + +

## PART 1 - GENERAL

### 1.01 - 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 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 1.02-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.

### 1.02 - SUBMITTALS

- A. Within 90 days of the effective date of the Notice to Proceed, submit plan for training conforming to the requirements of Section 01812 – Commissioning Summary, Instruction of Operations and Maintenance Personnel. Included in the plan shall be course outlines and schedules for training to be provided at the Supplier's facilities.

### 1.03 - 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, conforming to the requirements of Section 01812 – Commissioning Summary. The services of equipment manufacturer's representative(s) 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:

1. The I&C Supplier 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 shall provide 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 1.03-A and Paragraph 1.03-B, above.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 13404

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, 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 13401, Process Control System General Provisions
2. Section 13403, Process Control System Startup and Field Testing.
3. Section 13404, Process Control System Training.
4. Section 13440, Panel Mounted Instruments and Devices

1.02 - QUALITY ASSURANCE

A. Comply with the requirements of Section 13401 – Process Control Systems General Provisions.

B. 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 Systems General Provisions, and the detailed Specifications herein.

## 13420 – PRIMARY SENSORS AND FIELD INSTRUMENTS

2. Field supervision, inspection, start-up and training in accordance with the requirements of Section 13403, Startup and Field Testing, and Section 13404, Training.

### 1.03 - DELIVERY, STORAGE AND HANDLING

- A. Comply with the requirements of Section 13401 – Process Control Systems General Provisions and Section 01610 – Transportation and Handling of Materials and Equipment.
- 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.

### 1.04 - SUBMITTALS

- A. Comply with the requirements of Section 01300 – Submittals and Section 13401 – Process Control Systems General Provisions.

### 1.05 - 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.

### 1.06 - 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 tag 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 circllet 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

### 2.01 - GENERAL DESIGN REQUIREMENTS

- A. Power Supplies:
  1. All electrically powered equipment and devices shall be suitable for operation on 115 volt,  $\pm 10$  percent, 60 Hz,  $\pm 2$  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.
3. Primary sensors and field instruments shall conform to the requirements of the Instrument Data Sheets provided after PART 3 of these specifications.
4. The named manufacturers have been specified to establish the standard of quality and performance of equipment to be supplied.

2.02 – NON-CONTACT RADAR LEVEL METER

A. Sensor

1. Non-contact, microwave type level meter.
2. Function/Performance
  - a. Radar Frequency: 26GHz for continuous measurement.
  - b. Measuring Range: Range shall be suitable for the installation indicated,
  - c. Accuracy: Plus or minus 0.32 inches (8 mm)
  - d. Operating Temperature: –40 to 80 degrees C.
  - e. Output: Isolated 4-20 mA output.
  - f. Diagnostics: On-screen instructions and display of self-diagnostics.
3. Physical
  - a. Antenna shall be PVDF, Horn style, Type 316 stainless steel
  - b. Instrument shall be provided with a minimum Class 150 pound (DN 80, PN16) mounting flange to match material and class of mounting bracket.
  - c. Housing shall be NEMA 4X (IP66). Where the instrument is installed in a hazardous area, the housing shall be explosion-proof, approved for Class I,

Division 1, Groups C and D (EEx d IIB T4) installation. The instrument shall be certified for installation of the antenna in a Class I, Division 1, Groups C and D (Zone 0) environment.

d. Power Requirements: 24 VDC Loop powered

4. Accessories Required

- a. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.
- b. A manufacturer furnished reflector shall be provided and installed parallel to the instrument.
- c. Where required for calibration/programming, a hand-held programmer shall be provided.

5. Manufacturer Start-up and Training services

- a. Provide two days of manufacturer's start-up and training services as specified in the start-up and training services paragraph.

B. Transmitter

1. Type

- a. Remotely mounted, intelligent transmitter compatible with sensor provided.

2. Function/Performance

- a. Operating Temperature: -20 to 70 degrees C
- b. Output: 4-20 mA DC linear. Transmitter shall also communicate using HART protocol.
- c. Display: Digital indicator displaying level in engineering units remotely mounted on side of tank.
- d. Diagnostics: Self diagnostics with transmitter failure driving output to above or below out of range limits.
- e. LED indication of transmitter faults.
- f. Simulation capability for inputs and loop outputs.

3. Physical

- a. Housing shall be NEMA 4X (IP66). Where the instrument is installed in a hazardous area, the housing shall be explosion-proof, approved for Class I, Division 1, Groups C and D (EEx d IIB T4) installation. The instrument shall be



certified for installation of the antenna in a Class I, Division 1, Groups C and D (Zone 0) environment.

b. Transmitter shall be suitable for surface or pipe stand mounting.

c. Power Supply shall be 24 VDC loop powered.

4. Manufacturer(s)

a. Endress & Hauser Micropilot FMR51 with FHX50 display

b. Or Equal.

2.03 - MAGNETIC TYPE FLOW METERS

A. The magnetic flow meters shall be the magnetic-inductive type that produces a magnetic field by positioning the coils inside the flow tube. The flow meter sizes shall be as specified on the contract documents. Flow meters shall be the Toshiba Mount Anywhere Series – Flanged electromagnetic flow meter or equal.

B. Continuous zero stability shall be an inherent characteristic of the flow meter system. The system shall cancel out interference voltages, thus eliminating the zero-drift by loading the magnetic coils with a pulsed direct current (DC).

C. Measurement shall not be affected by alternating current (AC) line interference voltages, stratified flow, changes in liquid electrical conductivity (down to 5 micromhos/cm), or non-homogeneity of the fluids electrical conductivity. Zero point shall be stable even with partially fouled electrodes.

D. The flow meters must meet the following requirements:

1. General:

a. Function: Measure, indicate, and transmit the process flow in a full pipe. Meter must be a full bore meter with the magnetic field traversing the entire cross-section of the flow tube. Insertion magmeters or multiple single point probes inserted into a spool piece are not acceptable.

b. Type: Magnetic flowmeter, operating based on Faraday's law, using a pulsed DC type coil excitation with high impedance electrodes.

c. Parts: Flow tube, transmitter, interconnection cables, mounting hardware.

2. Service: as shown on the Contract Drawings.

3. Performance:

a. Range: 1500 to 1

b. Accuracy: 0.2%

c. Repeatability:  $\pm 0.05\%$  or  $\pm 0.0008$  ft/s, whichever is greater.

d. Calibration: High accuracy 0.2%

e. Flow range:

i. 30"Ø FST Flow Meters: 1 MGD to 20 MGD

ii. 14"Ø RAS Flow Meters: 0 MGD to 5 MGD

iii. 6"Ø WAS Flow Meters: 0 MGD to 5 MGD

4. Process Connection:
  - a. Meter Size: as indicated on the Contract Documents
  - b. Connection Type: ANSI 150 flanges
  - c. Flange Material: Carbon steel
  - d. Pressure Rating: Meter system must be fully rated to the same design pressure as the flanges.
5. Flow Tube:
  - a. Meter Tube Material: 304 stainless steel
  - b. Liner Material: Hard Rubber, suitable for wastewater sludge containing 1% solids and replaceable without disturbing the field coils.
  - c. Electrode Type: Conical self-cleaning electrodes.
  - d. Electrode Material: 316 stainless steel
  - e. Enclosure Classification: NEMA 4X, Explosion Proof for Class 1, Div. 2, Group D locations.
  - f. Housing Material: Epoxy Coated Carbon Steel
  - g. Grounding: Type 2 corrosion-resistant metallic grounding rings are required.
  - h. Submergence: Continuous to 30 feet and direct burial 3 to 16 feet IP68/NEMA6P.
6. Transmitter:
  - a. Power: 120VAC 60Hz
  - b. Display: Three-line 16 character back-lit display indicating instantaneous flow and total flow in GPM.
  - c. Integral Keypad: Allows for external configuration without removing covers and compromising the integrity of the electrical and environmental classifications.
  - d. Bi-direction flow: Forward and reverse flow indication and totalization
  - e. Totalizers: Three 9 digit totalizers for forward, reverse and net
  - f. Mounting: Remote mounting, not on the flow meter.
  - g. Enclosure: NEMA 4X Polypropylene with polycarbonate window
  - h. Input Impedance: 1015 ohms.
  - i. Isolation: Galvanic separation to 50V DC between analog, pulse/alarm, earth/ground.
  - j. Current Output: Two standard 4-20 mA, galvanically isolated. Maximum loop resistance 750 W.
  - k. Pulse Output: One standard 0-800Hz, <35VDC for forward and one for reverse.
  - l. Contact Outputs: Two programmable as standard.
  - m. Empty Pipe Detection: Required.
  - n. Remote Communications capability: Shall be capable of RS232/485, and HART Protocol, where required.

- o. Low flow cut off: Adjustable
  - p. Power consumption: < 20VA
  - q. Cable supplied: 30 feet minimum of shielded transmitter cable. Meter shall only require one cable and conduit between sensor and transmitter.
  - r. Maximum Cable length: 330 feet with standard cable, longer separation possible.
7. Calibration:
- a. Test Mode: Provide the ability to verify the accuracy of the unit and the integrity of the current loop without any external equipment.
  - b. Self-diagnostics: Internal checks of all outputs and displays.
  - c. Meter calibration shall be in accordance with OIML R49 Type P, self-calibration requirements.
  - d. Meter must be able to periodically generate simulated signals that verify that the output is within predefined limits.
  - e. Coil inductance and resistance along with electrode voltage and impedance must be verifiable through diagnostic functionality
  - f. Warnings and Alarms: Shall be classified to NAMUR NE 107 standards. Meter must have ability to display severity of warning with "maintenance, check-function, failure and out of spec" warning indications.
  - g. Alarm priorities shall be classified as: "None; Maintenance; Out-of-spec; Function check; and Error."
  - h. The quantity of occurrences, total time duration of the alarm occurrences, and time since last occurrence.
  - i. All replacement transmitters shall be interchangeable without need for programming sensor calibration factors, meter size, site information, and serial numbers
  - j. In-Situ Calibration Verification: This system shall be used to verify in a quantifiable manner the meter's current conditions versus the meter's condition when originally manufactured. This calibration verification of the meter shall be performed without need for physical access to the meter flow tube. The calibration verification shall meet or exceed the following requirements:
    - i. The original FINGERPRINT values shall be stored on a computer disk given to the owner.
    - ii. The verification process shall consist of at least 52 meter conditions pertaining to the primary coils, electrodes, interconnecting cable and signal converter.
    - iii. The coil verification shall include faults of continuity, impedance, resistance to ground, inductance, and magnetic field strength.
    - iv. The electrode verification shall include faults of continuity, impedance and insulation.
    - v. The cable verification shall include faults of coil, electrode, driven shield, and ground connections, cable cuts, cable damage, and water in the cable.

- vi. Signal converter verification shall include faults of current supply to coils, zero offset, span forward and reverse, electrode offset, current output, frequency output forward and reverse, driven shield to ground, overall shield to ground and signal ground connection to ground.
- vii. The calibration verification shall include the following: water ingress into the primary elements, faulty electrodes, dirty electrodes, electrode leakage, corroded electrodes, high process noise, liner failure, conductive coatings on the liner, insulating coatings on the liner, and primary element damage.
- viii. All tests shall be performed by means of comparison between the absolute values and change in values from the new conditions.
- ix. Verification standard shall be  $\pm 1\%$  of wet calibration for meters produced using the calibration verification service, or  $\pm 2\%$  for standard meters.
- x. The software shall be Windows based. This software shall be capable of generating a report based upon the result of the forgoing described tests. The software shall be capable of creating and storing an audit trail of the meter's conditions and the meter's history.
- xi. The calibration verification and metering system shall meet or exceed the standards established by the National Testing Laboratories.
- k. Meters to be designed, manufactured, and calibrated in an ISO9001, UKAS/NAMAS, NIST, or NATA certified facility. Flow facility must be certified by volume or weight certified provers. Facility must have the capability to hold the flow rate at the specified calibration points for a minimum of five minutes to allow stabilization for flow and repeatability point checks.

#### 2.04 - VENTURI FLOW METER

- A. The center flange shall be constructed of carbon steel and coated with epoxy paint. The flange shall have 304 stainless steel sleeves in the high and low pressure passages. The throat section shall be made of 304 stainless steel and shall have a cylindrical length equal to at least half the throat diameter. The pressure connections shall be stainless steel 0.25-inch NPT. The inlet and outlet cones shall be made of polyester resin reinforced with glass, 30% by weight.
- B. The venturi flow meter shall be Primary Flow Signal Model HVT-PIF or equal. The meter shall measure process air flow rate. The flow meter design operating temperature shall be 300°F.
- C. The Venturi center flange shall fit between the ANSI class 150 flanges of the mating pipe. The throat section shall be a cylinder with a length that is equal to half its diameter. The inlet transition section shall be a single 30 degree angle leading to the cylindrical throat section. Pressure connections for the high pressure and low pressure tap locations shall be 1/4-inch NPT-F and located 180-degrees apart in the horizontal plane of the center flange. The differential pressure produced by the Venturi meter shall indicate flow change only as a Herschel Standard Venturi tube without use of devices which employ entire or partial pitot effects, or which amplify the differential, or which introduce unwanted noise. Alternate devices that utilize converging multiple inlet angles or radius transitions shall not be allowed.
- D. Flow tubes with a throat design that magnifies the differential pressure shall not be acceptable.
- E. The effect of upstream piping on the accuracy of the venturi coefficient must be verified by calculations acceptable to the Engineer.
- F. The bench calibrated accuracy of the venturi shall be  $\pm 0.50\%$ . The flow calibrated accuracy of the venturi shall be  $\pm 0.25\%$ .

- G. The flow transmitter shall utilize silicon strain gauge sensor technology coupled to microprocessor based electronics. See 2.05 for flow transmitter.
- H. Each Venturi meter shall be flow calibrated by an independent flow laboratory with certified copies of the test results to substantiate the flow meter's accuracy, discharge coefficient and permanent pressure loss.

## 2.05 - DIFFERENTIAL PRESSURE TRANSMITTER FOR VENTURI FLOW ELEMENTS

### A. Type:

- 1. Microprocessor based, intelligent type to be used with Venturi tubes.

### B. Function/Performance:

- 1. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the differential pressure range to be metered.
- 2. Accuracy: 0.075 percent of span (linear output).
- 3. Operating Temperature: -4 to 176 degrees F.
- 4. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28 degrees C temperature change.
- 5. Static Pressure Effect: Effect on accuracy due to static pressure changes shall be negligible.
- 6. Output: 4-20 mA DC adjustable over the instrument range, with HART protocol. The output shall be proportional to the square root of the input differential pressure.
- 7. Stability: 0.05 percent of upper range limit for 1 year.
- 8. Display:
  - a. Digital indicator displaying flow in the engineering units indicated in the Instrument Device Schedule.
- 9. Diagnostics:
  - a. Self-diagnostics with transmitter failure driving output to above or below out of range limits.
  - b. Simulation capability for inputs and loop outputs.
  - c. Test terminals available to ease connection for test equipment without opening the loop.
  - d. Registers to record minimum and maximum pressure and temperatures transmitter has been exposed to shall be available.
- 10. Over Range Protection: Provide positive over range protection to 150 percent of the maximum pressure of the system being monitored by the instrument.

### C. Physical:

- 1. Enclosure: NEMA 4X (IP66), explosion proof, approved for Class I, Division 1, Groups C and D (EEx d IIC T5).
- 2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be Type 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O- rings shall be Teflon.
- 3. Power Supply: 24 VDC loop power.
- 4. Sensor Fill Fluid: Silicone.

### D. Power Requirements:

1. 24 VDC loop powered instrument.

E. Accessories Required:

1. Provide span and zero adjustment at each transmitter and through the handheld programming unit.
2. For air and clean water processes, provide a five valve manifold with each transmitter. The manifold shall be Type 316 stainless steel. Manifolds may be mounted directly to the instrument or separately mounted. Manifolds shall be by the instrument manufacturer or by D/A Manufacturing or Anderson Greenwood.
3. For dirty water or sludge applications, each transmitter shall be provided with integral remote armored capillary seals. The seal connection shall match the connection provided at the meter. The fluid in the seal shall meet the temperature requirements of the meter location.

F. Manufacturers:

1. ABB 264DS
2. Rosemount 3051
3. Foxboro IDP10
4. Siemens Sitrans P DS III
5. Endress & Hauser Deltabar PMD75

2.06 – DISSOLVED OXYGEN ANALYZER (OPTICAL TYPE SENSOR)

A. Electrode Cartridge/Sensor Assembly

1. Type: Continuous monitoring of dissolved oxygen by an optical sensor using either luminescence excited with blue light pulses technology or fluorescence quenching principle.
2. Function/Performance
  - a. Accuracy:  $\pm 0.1$  ppm (DO<1 ppm);  $\pm 0.2$  ppm.
  - b. Repeatability:  $\pm 0.01$  ppm.
  - c. Measuring Range: 0 to 20 ppm.
  - d. Sensitivity:  $\pm 0.05$  percent of span.
  - e. Measuring Range: 0 to 50 °C.
  - f. Materials on Construction: Noryl, polybutyl methacrolate, epoxy, polyurethane or PVC depending upon manufacturer.
  - g. Warranties: Probe, 3 years; Sensor, 1 year.
  - h. Rating: The sensor shall be rated for NEMA 6 submergence and electrical classification requirements for that location.
3. Accessories Required
  - a. One spare sensor cap for each set of ten or less sensor assemblies provided.
  - b. Sufficient cable for installation between the sensor and analyzer/controller as indicated on the Drawings.
  - c. One mounting bracket per sensor for fixing the sensor assembly to railing or other fixed support.
  - d. Ball float mounting kit or immersion mounting for sensor installation. Mounting kit shall be compatible with the existing slot in the aeration tank.
4. Manufacturers
  - a. HACH LDO sensor.
  - b. YSI DO sensor
  - c. Or equal.

B. Transmitter

1. Type

- a. Microprocessor based, compatible with sensor furnished
- 2. Function/Performance
  - a. Accuracy:  $\pm 0.1$  percent of span
  - b. Repeatability:  $\pm 0.05$  percent of span
  - c. Response Time: 60 seconds to 90 percent of value on step change
  - d. Temperature Range: -20 to 55°C
  - e. Output: 4-20mA
  - f. Temperature Compensation: Compensation over the temperature range of the instrument.
  - g. Diagnostics: On screen instructions and display of self-diagnostics.
  - h. Display: Digital indicator displaying concentration in PPM and temperature of the medium for each sensor in the system.
- 3. Physical
  - a. Suitable for rail mounting
  - b. Enclosure shall be NEMA 4X (IP 67)
  - c. Sunshield shall be provided
  - d. Power Requirements: 120 VAC/60Hz
- 4. Manufacturers
  - a. HACH SC4500 Controller
  - b. YSI IQ SensorNet 282 Controller
  - c. Or equal.
- C. Manufacturer Start-up and Training services
  - 1. The dissolved oxygen analyzer system manufacturer or manufacturer's certified service representative shall provide on-site start-up and training services.
  - 2. The start-up services shall be to calibrate, oversee the installations of the sensor, and start-up the sensor/transmitter in order to provide reliable measurement at the instrument and to the control system. The manufacturer shall work with the PCSS to verify that the correct information is being sent to the PLC system (i.e. that the scaling and units are the same at the instrument and on the remote operator interface). The manufacturer shall submit a calibration report in order to document the calibration procedure of the dissolved oxygen analyzer system. Provide a minimum of four (4) days of startup services.
  - 3. When starting up the system, the manufacturer shall provide training to the Owner's instrumentation technicians. The training shall be on how to calibration, install, troubleshoot, read the diagnostics, and maintain the system. Provide a minimum of eight (8) hours of training services.

## 2.07 – GAUGE PRESSURE TRANSMITTERS

- A. Type
  - 1. Microprocessor based, intelligent type.
- B. Function/Performance
  - 1. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the pressure range to be metered.
  - 2. Accuracy: 0.075 percent of span.
  - 3. Operating Temperature: -20 to 80 degrees C.
  - 4. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28 degrees C temperature change.
  - 5. Output: 4-20 mA DC linear with pressure, with HART protocol. Zero adjustable over the range of the instrument provided calibrated span is greater than the minimum calibrated span.
  - 6. Stability: 0.05 percent of upper range limit for 1 year.
  - 7. Display: Digital indicator displaying pressure.
  - 8. Diagnostics:
    - a. Self-diagnostics with transmitter failure driving output to above or below out of range

- limits.
- b. Simulation capability for inputs and loop outputs.
- c. Test terminals available to ease connection for test equipment without opening the loop.
- d. Registers to record minimum and maximum pressure and temperatures transmitter has been exposed to shall be available.
- e. Run-time clock available to determine usage for warranty purposes. 5-year warranty on this clock reading is included.
- 9. Over Range Protection: Provide positive over range protection to 150 percent of the maximum pressure of the system being monitored by the instrument.
- 10. If required to meet the range or suppression/elevation requirements, a differential pressure transmitter shall be provided.
- C. Physical
  - 1. Enclosure: NEMA 4X (IP66), explosion proof, approved for Class I, Division 1, Groups C and D (EEx d IIC T5).
  - 2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be Type 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.
  - 3. Power Supply: 24 VDC loop power.
  - 4. Sensor Fill Fluid: Silicone.
- D. Accessories Required
  - 1. Provide span and zero adjustment at each transmitter and through the handheld programming unit.
    - a. Configuration of the transmitter may be accomplished using the local display and pushbuttons without the use of an external programming device.
- E. Manufacturers
  - 1. Smar
  - 2. ABB
  - 3. Rosemount
  - 4. Foxboro
  - 5. Siemens Sitrans
  - 6. Or equal.

## 2.08 – PRESSURE SWITCH

- A. General
  - 1. Pressure switch shall be rated for use with wastewater.
  - 2. Enclosure shall be NEMA 4X, explosion proof, approved for Class I Division 1.
  - 3. Setpoint shall be adjustable from 15-100% of pressure range.
  - 4. Pressure Range: 10 to 150 PSI Spring Range, maximum working pressure of 300 PSI.
  - 5. Accuracy:  $\pm 1\%$  of span and range.
- B. Manufacturer
  - 1. Ashcroft or equal.

## 2.09 – PRIMARY SENSORS AND FIELD INSTRUMENTS

- A. General:
  - 1. All primary sensors and field instruments provided under other Sections shall comply with the requirements of this Section.
  - 2. Instruments and devices shall not be assembled in the panels until all product information and system shop drawings for respective components have been approved.



PART 3 – EXECUTION

3.01 - 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.

3.02 - 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.

END OF SECTION 13420

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## 13430 – PROCESS CONTROL PANELS AND ENCLOSURES

### 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, 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 System Low Pressure Air Pass Control Panels
  - b. Aeration System Low Pressure Air Grid Control Panels

##### B. Related Sections:

1. Section 03300 - Cast-In-Place Concrete.
2. Section 13401 - Process Control System General Provisions.
3. Section 13403 - Process Control System Start up and Field Testing.
4. Section 13404 – Process Control Systems Training
5. Section 13420 – Primary Sensors and Field Instruments
6. Section 13440 - Panel Mounted Instruments and Devices.
7. Section 13451 - PLC Hardware and Software.
8. Division 16, Electrical.

#### 1.02 - 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).
  - e. Operational Safety and Health Administration Regulations, (OSHA).
  - f. Underwriters' Laboratory, Inc., (UL).
  - g. State and Local code requirements.

## 13430 – PROCESS CONTROL PANELS AND ENCLOSURES

- h. 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.
- B. General Design Requirements:
  - 1. Comply with the requirements of Section 13401, Process Control System General Provisions.
- C. Factory Assembly and Testing:
  - 1. Manufacturer shall test prior to delivery to site.

### 1.03 - SUBMITTALS

- A. Comply with the requirements of Section 13401, Process Control System General Provisions.

### 1.04 - DELIVERY, STORAGE AND HANDLING

- A. Comply with the requirements of Section 13401, Process Control System General Provisions.

## PART 2 - PRODUCTS

### 2.01 - GENERAL CONSTRUCTION REQUIREMENTS

- A. Provide all electrical and/or pneumatic 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 fluorescent light fixtures with 40 watt 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.

## 2.02 - 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 Process and Instrumentation Diagrams.
  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. Tag all pneumatic lines.

## 13430 – PROCESS CONTROL PANELS AND ENCLOSURES

3. Numerically tag all terminal blocks on terminal strips.
4. Color code and numerically tag wiring at each end.
5. 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

### 2.03 - 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.

#### B. Construction Features:

1. Low Pressure Air Pass and Grid Control Panels shall be NEMA 4X rated.
  - a. Panels shall be Type 316L stainless steel construction with a minimum thickness of 12-gage for all surfaces (except those areas requiring reinforcement) having a smooth brushed finish.
  - b. Stainless steel 3-point latch system with handle on front 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.
2. Communication Cabinet shall be NEMA 4X rated.

- a. Panels shall be Type 316L stainless steel construction with a minimum thickness of 12-gage 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. Wall Mounted (to be mounted on stainless steel channel rack)

C. Electrical Systems:

1. Control of Environment:

a. Indoor Panels:

- 1) Provide adequately sized, automatically controlled 120 VAC strip heaters to maintain temperature 10°F 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.
- 3) Air conditioner shall have a minimum capacity of 4,000 BTU.
- 4) Provide documentation 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 thermo-plastic insulation rated for 600 V at 90°C 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 2.02-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 8x20 $\mu$ s 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

#### 3.01 - INSTALLATION

- A. Install equipment in conformance with NEC.
- B. 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.

## 13430 – PROCESS CONTROL PANELS AND ENCLOSURES

- 3. Provide concrete work in conformance with Section 03300, Cast-In-Place Concrete.
- C. Install anchor bolts and anchor in accordance with Section 05050, Metal Fastening.
- D. 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.

### 3.02 - TESTING AND ADJUSTMENTS

- A. Perform system testing and make any adjustments necessary in accordance with this Section, Section 13401, Process Control System General Provisions and Section 13403, Process Control System Start up and Field Testing.
- B. Perform power supply, voltage adjustments to tolerances required by the appurtenant equipment.

END OF SECTION 13430

## 13440 – PANEL MOUNTED INSTRUMENTS AND DEVICES

### 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, 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.

#### 1.02 - 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:

## 13440 – PANEL MOUNTED INSTRUMENTS AND DEVICES

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 Process and Instrumentation Diagram.
  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.

## 13440 – PANEL MOUNTED INSTRUMENTS AND DEVICES

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.
- G. 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, 277/480V NEMA rated circuit 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.

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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.

### 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 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 and within 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 20 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  $\pm 0.5$  Hz.
7. Operating Temperature: 1°C to 40°C.

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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:

1. Best Power Technology, Ferrups FE Series.
2. American Power Conversion Corp. (APC)
3. Eaton.
4. 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. 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.

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- 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.



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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:

## 13440 – PANEL MOUNTED INSTRUMENTS AND DEVICES

1. Decibel Output: minimum of 100dB at 10 feet from panel.
2. Enclosure Rating: NEMA 4X or NEMA7 in classified areas.
3. Horn Diaphragm: Stainless steel.
4. Power: 120 VAC.
5. Operating Temperature: 32 to 120°F.

### C. Products and Manufacturers:

1. Federal Signal.
2. Edwards
3. 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: LED, 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. Edwards
3. 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.

13440 – PANEL MOUNTED INSTRUMENTS AND DEVICES

END OF SECTION 13440

PART 1 - GENERAL

1.01 - DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment and incidentals required to furnish and install Programmable Logic Controllers (PLCs), Operator Interface Terminals (OITs), and associated software in control panels as shown and specified.
2. The hardware and architecture of the system shall be that of a PLC. A Distributed Control System (DCS), hybrid PLC based system, or a PLC and components no longer supported or being removed from support within two years by PLC manufacturer shall not be acceptable.
3. An Input / Output point list with I/O tag, point description, and other related details is provided in Section 13480, Input / Output Point List. The hardware required for the PLC is comprised of the following types of major components:
  - a. Ethernet TCP/IP Communication System.
  - b. Fault tolerant redundant processors configured as Hot Standby.
  - c. I/O drivers to communicate with PLC's.
  - d. Network communication devices.
  - e. Power Supplies.
  - f. I/O Cards.
  - g. I/O Chassis and Cabling.
  - h. Operator Interface Terminals (OIT)
  - i. Peripheral Devices.
4. The PLCs shall be networked as a system and operate as one integrated system. Contractor shall provide all software and drivers required to integrate with other microprocessor based systems into the networked PLC system to form a fully integrated system.

B. Related Sections:

1. Section 13401 - Process Control System General Provisions.
3. Section 13404 - Process Control System Training.
4. Section 13420 – Primary Sensors and Field Instruments
5. Section 13430 - Panels and Enclosure.
5. Section 13440 – Panel Mounted Instruments and Devices

6. Section 13480, Input/Output Point List.
7. Division 16, Electrical.

## 1.02 - TERMS

- A. The terms listed below are used throughout this Section and are defined as such:
1. Operator Interface Terminal (OIT): Operator Interface to control system. Allows operator intervention and monitoring of all systems and subsystems connected to the PLC system.
  2. Programmable Logic Controller (PLC): The controlling device used to control and monitor hardware connected to it by way of networks or I/O cards. May be identified under different names such as small logic controller, mini or micro.
  3. Backplane: Usually will indicate the I/O chassis that the power supply, PLC and I/O cards, and network cards reside in.
  4. I/O Cards: Can be either analog or discrete cards that interface between field devices and PLC.
  5. Network Hub: Data concentrator where one or more networks are integrated.
  6. Server: Computer having one or more CPU's used for a specific task such as data depository, web management. Usually connected to the plant network.
  7. Peripheral Devices: Includes, but not limited to, printer(s), display devices and standalone intelligent devices, such as remote HMI stations.
  8. PLC System: Includes all parts listed above.

## 1.03 - QUALITY ASSURANCE

- A. Contractor shall engage the services of the PLC manufacturer to provide technical support for equipment listed in this Section.

## 1.04 - WARRANTY

- A. Contractor shall provide warranty that includes labor and parts for 2 year period.

## 1.05 – OPERATION AND MAINTENANCE DATA

- A. The Instrumentation and Controls (I&C) Supplier shall provide trouble-shooting procedures for hardware supplied. The procedures shall be accurate, easy to understand and follow, current, and comprehensive in scope. If links to vendor website or technical support is necessary the vendor shall provide up-to-date phone numbers, email address, and links.

## PART 2 - PRODUCTS

### 2.01 - PROGRAMMABLE LOGIC CONTROLLER (PLC)

- A. The PLC system shall include as a minimum a power supply, network connections, I/O cards and CPU as shown and as required to achieve the specified functionality. The system shall be complete with all necessary processors, I/O modules, backplanes, power supplies, terminals, terminal bases, and cables. The plant control system hardware listed herein is provided for Contractor's convenience and may not include all PLC hardware components that shall be provided.

- B. The final system configuration shall utilize the System Manufacturer's standard hardware and software to meet the functional requirements of these Specifications.
- C. All equipment furnished under this Contract shall be provided to meet the functional requirements of these Specifications plus a 20 percent growth in project requirements, (e.g., graphic displays, alarms, additional instrumentation and equipment). All equipment shall be provided under this Contract, such that the entire 20 percent project growth can be implemented into the PLC, without any additional hardware cost to the OWNER.
- D. The PLC shall have the ability to communicate with multiple remote I/O racks, or devices configured with multiple I/O modules. The PLC shall have the ability to support multiple data communications networks in the same chassis
- E. Assembled System:
  - 1. Within the enclosure all I/O racks, processor racks, and power supplies shall be grounded to meet the manufacturer's specifications.
  - 2. Provide a dry contact rated at 2 amperes and 120 volts a-c for remote indication of processor failure.
  - 3. PLCs shall be capable of being programmed and updated where installed.
  - 4. Provide interposing relays for all outputs to motor control centers, solenoids or contactor circuits.
  - 5. Provide individual fuses for all inputs and 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.
- F. The PLC shall perform the following functions:
  - 1. The programming format shall be IEC 1131-3 compliant Ladder Diagram (LD), Function Block Diagram (FBD), Sequential Function Chart (SFC), and Structured Text (ST) languages.
  - 2. Accept analog input signals (4 to 20 mADC) and dry contact input signals (120 VAC).
  - 3. All analog inputs shall have 16-bit resolution with 0.025 percent accuracy.
  - 4. Output analog signals (4 to 20 mADC) and contact output commands as required to meet interface requirements. Contact outputs shall be dry contacts rated for 120 vac, 60 Hz, two amp service or 24 VDC.
  - 5. Respond to interrogations for data and receive downloaded program changes and operating parameter changes from OIT's or engineering workstation.
  - 6. Errors and/or failures shall be indicated locally by Light Emitting Diode (LED) and reported at the OIT. Multiple-bit errors shall cause immediate processor halt. Error diagnostic tables shall be user accessible and provide clear and accurate descriptions of PLC system and process level errors.

7. All I/O boards shall be capable of being removed without powering down any process controller resource.
  8. The unit shall be provided with the following timing elements:
    - a. Real-time clock to provide time reference for processor and system operations.
    - b. Watchdog timer for monitoring system software operations to detect hardware malfunction or a non-productive loop (stall condition).
  8. The processor should be able to perform basic arithmetic operations using floating-point data.
  9. A single fault tolerant power supply shall be provided for each CPU, rack and I/O modules. Each power supply shall be capable of being powered from separate 120 Vac and 24 or 125 Vdc sources. The power supplies shall incorporate full power factor correction, AC input filtering, and a 40-millisecond hold up time.
  10. Isolation transformers and other power normalization devices to protect against over voltage and frequency distortion characteristics shall be used where frequent power failures are common.
- G. The PLC should have as a minimum the following features and capabilities:
1. Ethernet Remote I/O drop adaptor:
    - a. Minimum of 3 integrated RJ45 ports.
    - b. The controller shall be able to operate within the following environmental parameters: Shall be capable of withstanding ambient air temperatures of -13°F to 140°F.
    - c. Provide either of the following:
      - 1) BMECRA31210, by Schneider-Electric.
      - 2) Or approved equal.
  2. Current Input Module:
    - a. 4-20 mADC.
    - b. Minimum of 8 isolated input channels.
    - c. Provide the following:
      - 1) BMXAMI0810, by Schneider-Electric.
      - 2) Or approved equal.
  3. Current Output Module:
    - a. 4-20 mADC.

- b. Minimum of 8 isolated output channels.
  - c. Provide either of the following:
    - 1) BMXAMO0802, by Schneider-Electric.
    - 2) Or approved equal.
- 4. Discrete Digital Input Module:
  - a. 120VAC voltage monitor.
  - b. Minimum of 16 individually isolated input channels.
  - c. Provide either of the following:
    - 1) BMXDAI1602, by Schneider-Electric.
    - 2) Or approved equal.
- 5. Discrete Digital Contact Output Module:
  - a. Relay output (NO contacts, 120VAC 2A minimum).
  - b. Minimum of 16 individually isolated output channels.
  - c. Provide either of the following
    - 1) BMXDAO1615, by Schneider-Electric.
    - 2) Or approved equal.
- 6. Ethernet Interface Module:
  - a. Standard Ethernet media (10base2, 10base5, 10baseT, 100baseT, fiber).
  - b. RJ-45 interface.
  - c. Standard TCP/IP communications.
  - d. Subnet masking.
- 8. I/O Backplate:
  - a. Number of slots as needed.
  - b. Provide either of the following
    - 1) BMEXBP0800, by Schneider-Electric.
    - 2) Or approved equal.
- 8. Power Supply (PS):



- a. 120VAC input voltage.
  - b. Minimum current output as required to power all local modules.
  - c. Provide either of the following
    - 1) BMXCPS3500, by Schneider-Electric.
    - 2) Or approved equal.
9. Fiber Optic Converter Module:
- a. Two (2) RJ45 100Base-TX
  - b. Two (2) Fiber Optic 100 Base-FX.
  - c. Provide either of the following
    - 1) BMXNRP0200, by Schneider-Electric.
    - 2) Or approved equal.
- H. PLC Spare Parts:
- 1. See specification Section 13401, Process Control System General Provisions for the complete list of PLC spare parts.

## 2.02 - PLC PROGRAMMING SOFTWARE

- A. Software shall support the development of the PLC ladder logic derived from process control strategies as specified in Section 13491, Process Control Descriptions. Software shall be IEC 1131-3 compliant Ladder Diagram as well as modular, function block type of control elements, which are familiar to control system programmers and engineers, instrumentation technicians and electricians. The function blocks shall be computational blocks for performing arithmetic, operational blocks for performing such functions as move and convert values, file to file operations, communication blocks for communicating with other PLC's and system resources, special algorithm blocks for advanced control procedures such as shift register, and PID functions. The PID shall use traditional strategies such as Proportional Integral Derivative (PID) controllers, feed forward, cascaded controllers, etc. shall be provided. Tuning constants shall be easily set from operator consoles. For each analog loop, software to allow provision of status of the manual backup control to be monitored and an alarm generated when switch is not in automatic mode.
- B. For each sequence or logic control loop, a disagreement alarm shall be triggered when a command (start-stop, etc.) is initiated and confirmation is not received.
- C. Software shall allow configuration of internal diagnostics alarms for the PLC hardware. Alarms shall be suitable to verify proper and to alert operators when alarm conditions occur. This includes but is not limited to annunciation blown fuse indication for all I/O, watchdogs for communications failure with any system processor or I/O address, and communications failure with existing third-party equipment.
- D. PLC software shall allow for editing of comments and other PLC documentation using traditional editors such as Notepad.

- E. PLC software shall include an easy to use file and printing management module.
- F. The PLC software shall use intuitive, menu-driver environment and base package platform. These easy-to-use Graphical User Interface (GUI) packages shall perform configuration and maintenance operations.
- G. The PLC software shall be compatible with Windows 10, 64 bits or latest version.
- H. The PLC software shall be fully compatible with all furnished PLC hardware.
- I. Product and Manufacturer:
  - 1. Provide one complete licensed software package of RSLogix 5000 Full Edition, RSLinx Professional, RSNetWorx for ControlNet and all software needed to configure the redundant system, latest version, by Rockwell Automation.
  - 2. Or approved equal.

#### 2.03 - OPERATOR INTERFACE TERMINAL (OIT)

- A. Provide a programmable Operator Interface Terminal (OIT) to enable Operator to 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 or 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.
- C. Each OIT shall be provided with the following minimum requirements:
  - 1. Display: 15-inch Color TFT, 1024 x 768, multi-touch analog resistive touch screen.
  - 2. Memory: Available Flash: 512MB; RAM: 512MB.
  - 3. Communication: Ethernet, RS-232,
  - 4. Input Voltage: 12 – 24VDC.
  - 5. Power Consumption: 22 Watts (maximum).
  - 6. Operating Temperature: 0 – 60 degrees Celsius.
  - 7. Humidity: 10 - 90% without condensation.
  - 8. Rating: NEMA 4X, UL-listed.
- D. Manufacturers:

1. Provide operator interface terminals (OIT) of the same manufacturer as the PLC hardware provided. The OIT shall be one of the following:
  - a. Harmony GTU (HMIDT732 and HMIG5U2), 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 one Ethernet 10/100 Mbps for connectivity or programming.
2. OIT shall have a minimum of one Serial RS232 port.
3. Compact flash ports shall be Type 2.
4. OIT shall have a minimum of one USB port.

G. Display:

1. Display resolution shall be a minimum 1024 x 768.
2. Display shall support touch screen input.

H. Environmental:

1. Rating: OIT shall be rated to maintain the rating of the control panel it will be mounted in.

I. Screens:

1. Contractor shall be responsible for updating/modifying the existing SCADA system to include all new screens and new I/O points added under this project.
2. Dedicated OIT screens shall be provided for the following:
  - a. All major process equipment with a separate overview screen for each site. 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:

- i. Tank # Pass # Dissolved Oxygen Level
  - ii. Tank # Pass # Air Flow
  - iii. Tank # Pass # Valve Position Feedback (0-100%)
  - iv. Tank # Pass # Valve Local-Remote Control
  - v. Tank # Pass # Valve Grid # Air Flow
  - vi. Tank # Pass # Valve Grid # Valve Local-Remote Control
  - vii. Tank # Pass # Valve Grid # Open-Close Control
  - viii. RAS Pumps Speed Command/Reference Feedback
  - ix. RAS Pumps Monitoring System
  - x. RAS Pump Suction/Discharge Pressure
- b. All process trend variables for each site. Dynamic trend displays shall plot at least eight (8) user selectable analog values per site in an x-y axis format, with each plot using a unique color. Trends shall be plottable using current and/or historical data, with the ability to trend backward from a given time reference using a single command. The user shall be able to view exact numeric values for any point in the trend by moving the mouse to a given point in the graphic. The trend displays shall use shading to represent when a particular point crosses a reference value.
- i. Trending system shall be capable of trending historical and real-time data simultaneously for comparison purposes.
  - ii. Trending system shall be capable of allowing the user to zoom in on data as highlighted by the operator using a selectable window.
  - iii. Trending system shall be capable of exporting information to a data file that is readily accessible from a standard spreadsheet software.
- c. All alarms and events for each site. Alarm monitoring of discrete and analog I/O shall be provided. Alarms shall be capable of being assigned to one of three categories of severity with each producing a distinct sound via the system speaker/horn.
- i. In order to divide the process alarms and events into easily readable screens, the system shall allow for named individual alarm groups to be defined. The groups shall be definable on an individual tag level, and all alarms shall be accessible by each tag.

- ii. Alarm conditions shall be specified as a discrete input or output change of state, analog values above and below limits, high or low analog rate-of-change as defined in the database, or failed communication link.
- iii. The system shall print a descriptive message with a time stamp and user ID on the alarm printer or to an alarm file whenever any of the following events occur:
  - 1. Alarm
  - 2. Alarm acknowledgment
  - 3. Data entry into a tag
  - 4. Restarting the OIT software
- iv. Error Detection, Recovery and Diagnostics
  - 1. Display current status and operation of local network.
  - 2. OIT software shall automatically detect and recover from any network condition or software problem that results in a failure of communications between the OIT and SCADA servers and I/O devices.
  - 3. All connection/disconnection events shall be logged.
  - 4. Upon reconnection data shall be updated with information from back-up server.
- v. Historical Data
  - 1. Archiving of all historical data for long-term storage and retrieval.
- vi. Security
  - 1. Minimum of four levels of security to prevent unauthorized usage or modification of the system.

### PART 3 - EXECUTION

#### 3.01 - ENVIRONMENTAL CONDITIONS

- A. The complete monitoring and control system and associated input/output wiring will be used in a wastewater treatment facility environment where there will be high energy AC fields, DC control pulses, and varying ground potentials between the transducers or input contact locations and the system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.
- B. The PLC components shall be designed and constructed for satisfactory operation and long, low maintenance service under the following environmental conditions:
  - 1. Temperature range: 32 to 122°F continuous.

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2. Relative humidity: 5 through 95 percent (non-condensing).

END OF SECTION 13451

## PART 1 - GENERAL

### 1.01 - DESCRIPTION

- A. 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 13451, PLC Hardware and Software.

### 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 next alpha character is the functional identifier and follows ANSI/ISA-S5.1. In the example, the "F" represents flow.
  - 2. The next alpha character (I) is the function identifier. In the example, the "I" represents an analog input.
  - 3. (I-8), and loop or field device (13)
  - 4. The four-digit number (0123) identifies the loop or field device.
  - 5. 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. "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.
  6. ENT designates Ethernet communications (All Types of Inputs/Outputs).
- E. "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.
- F. "ENGINEERING UNITS" denotes the unit type as it applies to the RANGE. Information in this column shall be provided by Contractor.
- G. "POWER FROM" indicates where power for the instrument/device producing the signal originates from.
- H. "SIGNAL FROM DEVICE" indicates the instrument/device which produces the signal.
- I. "SIGNAL FROM TB" is the terminal block number where the signal wire is terminated. Information in this column shall be provided by Contractor.
- J. "SIGNAL FROM TERMINAL #" is the terminal number where the signal wire is terminated. Information in this column shall be provided by Contractor.
- K. "SIGNAL TO DEVICE" indicates the instrument/device which receives the signal.
- L. "SIGNAL TO TB." is the terminal block number where the signal wire is terminated. Information in this column shall be provided by Contractor.
- M. "SIGNAL TO TERMINAL #" is the terminal number where the signal wire is terminated. Information in this column shall be provided by Contractor.
- N. "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.

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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 13480

Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements					Abbreviations		
					DI:	Digital Input	
					DO:	Digital Output	
					AI:	Analog Input	
					AO:	Analog Output	
					MB:	Modbus	
EN:	Ethernet						
Partial Air Treatment Control Cabinet No. 1 I/O List (ATCC-1)							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
DI	1	Final Sedimentation Tank No. 9 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	2	Final Sedimentation Tank No. 9 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	3	Final Sedimentation Tank No. 9 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	4	Final Sedimentation Tank No. 10 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	5	Final Sedimentation Tank No. 10 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	6	Final Sedimentation Tank No. 10 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	7	Final Sedimentation Tank No. 11 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	8	Final Sedimentation Tank No. 11 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	9	Final Sedimentation Tank No. 11 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	10	Final Sedimentation Tank No. 12 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	11	Final Sedimentation Tank No. 12 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	12	Final Sedimentation Tank No. 12 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	13	Final Sedimentation Tank No. 13 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	14	Final Sedimentation Tank No. 13 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	15	Final Sedimentation Tank No. 13 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	16	Final Sedimentation Tank No. 14 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	17	Final Sedimentation Tank No. 14 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	18	Final Sedimentation Tank No. 14 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	19	RAS-Pump 1 - Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	20	RAS-Pump 1 - Remote	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	21	RAS-Pump 1 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DI	22	RAS-Pump 1 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DI	23	RAS-Pump 1 - Fault	1	N/A	N/A	New I/O	N/A
DI	24	RAS-Pump 2 - Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	25	RAS-Pump 2 - Remote	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	26	RAS-Pump 2 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DI	27	RAS-Pump 2 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DI	28	RAS-Pump 2 - Fault	1	N/A	N/A	New I/O	N/A
DI	29	RAS-Pump 3 - Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	30	RAS-Pump 3 - Remote	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	31	RAS-Pump 3 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DI	32	RAS-Pump 3 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DI	33	RAS-Pump 3 - Fault	1	N/A	N/A	New I/O	N/A
DI	34	RAS-Pump 4 - Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	35	RAS-Pump 4 - Remote	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	36	RAS-Pump 4 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DI	37	RAS-Pump 4 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A

Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements					Abbreviations		
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					DO:	Digital Output	
					AI:	Analog Input	
					AO:	Analog Output	
					MB:	Modbus	
EN:	Ethernet						
Partial Air Treatment Control Cabinet No. 1 I/O List (ATCC-1)							
DI	38	RAS-Pump 4 - Fault	1	N/A	N/A	New I/O	N/A
DI	39	RAS-Pump 5 - Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	40	RAS-Pump 5 - Remote	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	41	RAS-Pump 5 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DI	42	RAS-Pump 5 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DI	43	RAS-Pump 5 - Fault	1	N/A	N/A	New I/O	N/A
DI	44	RAS Flow From Final Tank No. 9 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51091
DI	45	RAS Flow From Final Tank No. 10 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51101
DI	46	RAS Flow From Final Tank No. 11 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51111
DI	47	RAS Flow From Final Tank No. 12 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51121
DI	48	RAS Flow From Final Tank No. 13 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51131
DI	49	RAS Flow From Final Tank No. 14 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51141
DO	1	RAS-Pump 1 - Start/Stop	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DO	2	RAS-Pump 1 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DO	3	RAS-Pump 1 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DO	4	RAS-Pump 2 - Start/Stop	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DO	5	RAS-Pump 2 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DO	6	RAS-Pump 2 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DO	7	RAS-Pump 3 - Start/Stop	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DO	8	RAS-Pump 3 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DO	9	RAS-Pump 3 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DO	10	RAS-Pump 4 - Start/Stop	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DO	11	RAS-Pump 4 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DO	12	RAS-Pump 4 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DO	13	RAS-Pump 5 - Start/Stop	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DO	14	RAS-Pump 5 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DO	15	RAS-Pump 5 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
AI	1	Final Sedimentation Tank No. 9 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50091
AI	2	Final Sedimentation Tank No. 9 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50091
AI	3	Final Sedimentation Tank No. 9 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51091
AI	4	Final Sedimentation Tank No. 10 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50101
AI	5	Final Sedimentation Tank No. 10 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50101
AI	6	Final Sedimentation Tank No. 10 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51101
AI	7	Final Sedimentation Tank No. 11 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50111
AI	8	Final Sedimentation Tank No. 11 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50111
AI	9	Final Sedimentation Tank No. 11 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51111
AI	10	Final Sedimentation Tank No. 12 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50121
AI	11	Final Sedimentation Tank No. 12 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50121

Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements					Abbreviations		
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					MB:	Modbus	
					EN:	Ethernet	
Partial Air Treatment Control Cabinet No. 1 I/O List (ATCC-1)							
AI	12	Final Sedimentation Tank No. 12 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51121
AI	13	Final Sedimentation Tank No. 13 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50131
AI	14	Final Sedimentation Tank No. 13 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50131
AI	15	Final Sedimentation Tank No. 13 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51131
AI	16	Final Sedimentation Tank No. 14 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50141
AI	17	Final Sedimentation Tank No. 14 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50141
AI	18	Final Sedimentation Tank No. 14 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51141
AI	19	Return Activated Sludge to Aeration Tank 4 Pass A Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51401
AI	20	Return Activated Sludge to Aeration Tank 4 Pass C Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT51403
AI	21	Return Activated Sludge to Aeration Tank 5 Pass A Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51501
AI	22	Return Activated Sludge to Aeration Tank 5 Pass C Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT51503
AI	23	Return Activated Sludge to Aeration Tank 6 Pass A Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51601
AI	24	Return Activated Sludge to Aeration Tank 6 Pass C Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT51603
AI	25	RAS-Pump 1 - Speed Reference	1	0-100	%	Existing I/O to be Re-Used	SI-51907
AI	26	RAS-Pump 1 - Suction Pressure	1	TBD	PSI	New I/O	PIT-51907-A
AI	27	RAS-Pump 1 - Discharge Pressure	1	TBD	PSI	New I/O	PIT-51907-B
AI	28	RAS-Pump 2 - Speed Reference	1	0-100	%	Existing I/O to be Re-Used	SI-51908
AI	29	RAS-Pump 2 - Suction Pressure	1	TBD	PSI	New I/O	PIT-51908-A
AI	30	RAS-Pump 2 - Discharge Pressure	1	TBD	PSI	New I/O	PIT-51908-B
AI	31	RAS-Pump 3 - Speed Reference	1	0-100	%	Existing I/O to be Re-Used	SI-51909
AI	32	RAS-Pump 3 - Suction Pressure	1	TBD	PSI	New I/O	PIT-51909-A
AI	33	RAS-Pump 3 - Discharge Pressure	1	TBD	PSI	New I/O	PIT-51909-B
AI	34	RAS-Pump 4 - Speed Reference	1	0-100	%	Existing I/O to be Re-Used	SI-51910
AI	35	RAS-Pump 4 - Suction Pressure	1	TBD	PSI	New I/O	PIT-51910-A
AI	36	RAS-Pump 4 - Discharge Pressure	1	TBD	PSI	New I/O	PIT-51910-B
AI	37	RAS-Pump 5 - Speed Reference	1	0-100	%	Existing I/O to be Re-Used	SI-51911
AI	38	RAS-Pump 5 - Suction Pressure	1	TBD	PSI	New I/O	PIT-51911-A
AI	39	RAS-Pump 5 - Discharge Pressure	1	TBD	PSI	New I/O	PIT-51911-B
AI	40	RAS Flow From Final Tank No. 9 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51091
AI	41	RAS Flow From Final Tank No. 10 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51101
AI	42	RAS Flow From Final Tank No. 11 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51111
AI	43	RAS Flow From Final Tank No. 12 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51121
AI	44	RAS Flow From Final Tank No. 13 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51131
AI	45	RAS Flow From Final Tank No. 14 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51141
AO	1	Final Sedimentation Tank No. 9 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50091
AO	2	Final Sedimentation Tank No. 10 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50101
AO	3	Final Sedimentation Tank No. 11 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50111
AO	4	Final Sedimentation Tank No. 12 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50121

Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements					Abbreviations		
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Partial Air Treatment Control Cabinet No. 1 I/O List (ATCC-1)							
AO	5	Final Sedimentation Tank No. 13 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50131
AO	6	Final Sedimentation Tank No. 14 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50141
AO	7	RAS-Pump 1 - Speed Command	1	0-100	%	Existing I/O to be Re-Used	SIC-51907
AO	8	RAS-Pump 2 - Speed Command	1	0-100	%	Existing I/O to be Re-Used	SIC-51908
AO	9	RAS-Pump 3 - Speed Command	1	0-100	%	Existing I/O to be Re-Used	SIC-51909
AO	10	RAS-Pump 4 - Speed Command	1	0-100	%	Existing I/O to be Re-Used	SIC-51910
AO	11	RAS-Pump 5 - Speed Command	1	0-100	%	Existing I/O to be Re-Used	SIC-51911
AO	12	RAS Flow From Final Tank No. 9 - Pneumatic Valve Positioner	1	0-100	%	Existing I/O to be Re-Used	CV-51091
AO	13	RAS Flow From Final Tank No. 10 - Pneumatic Valve Positioner	1	0-100	%	Existing I/O to be Re-Used	CV-51101
AO	14	RAS Flow From Final Tank No. 11 - Pneumatic Valve Positioner	1	0-100	%	Existing I/O to be Re-Used	CV-51111
AO	15	RAS Flow From Final Tank No. 12 - Pneumatic Valve Positioner	1	0-100	%	Existing I/O to be Re-Used	CV-51121
AO	16	RAS Flow From Final Tank No. 13 - Pneumatic Valve Positioner	1	0-100	%	Existing I/O to be Re-Used	CV-51131
AO	17	RAS Flow From Final Tank No. 14 - Pneumatic Valve Positioner	1	0-100	%	Existing I/O to be Re-Used	CV-51141
EN	1	RAS-Pump 1 - Stator Overtemp	1	N/A	N/A	New I/O	N/A
EN	2	RAS Pump 1 - Bearing Overtemp	1	N/A	N/A	New I/O	N/A
EN	3	RAS Pump 1 - High Vibration	1	N/A	N/A	New I/O	N/A
EN	4	RAS Pump 1 - Seal Leak	1	N/A	N/A	New I/O	N/A
EN	5	RAS Pump 1 - Temp Stator Phase 1	1	N/A	N/A	New I/O	N/A
EN	6	RAS Pump 1 - Temp Stator Phase 2	1	N/A	N/A	New I/O	N/A
EN	7	RAS Pump 1 - Temp Stator Phase 3	1	N/A	N/A	New I/O	N/A
EN	8	RAS Pump 1 - Temp Main Bearing	1	N/A	N/A	New I/O	N/A
EN	9	RAS Pump 1 - Temp Support Bearing	1	N/A	N/A	New I/O	N/A
EN	10	RAS Pump 1 - Total Starts	1	N/A	N/A	New I/O	N/A
EN	11	RAS Pump 1 - Service Time	1	N/A	N/A	New I/O	N/A
EN	12	RAS Pump 1 - AC Current	1	N/A	N/A	New I/O	N/A
EN	13	RAS Pump 1 - Vibration Total	1	N/A	N/A	New I/O	N/A
EN	14	RAS Pump 1 - Vibration X Dimension	1	N/A	N/A	New I/O	N/A
EN	15	RAS Pump 1 - Vibration Y Dimension	1	N/A	N/A	New I/O	N/A
EN	16	RAS Pump 1 - PTC/Thermistor	1	N/A	N/A	New I/O	N/A
EN	17	RAS Pump 1 - Leakage FLS1	1	N/A	N/A	New I/O	N/A
EN	18	RAS Pump 1 - Leakage FLS2	1	N/A	N/A	New I/O	N/A
EN	19	RAS Pump 1 - Leakage CLS (Water in Oil Sensor)	1	N/A	N/A	New I/O	N/A
EN	20	RAS-Pump 2 - Stator Overtemp	1	N/A	N/A	New I/O	N/A
EN	21	RAS Pump 2 - Bearing Overtemp	1	N/A	N/A	New I/O	N/A
EN	22	RAS Pump 2 - High Vibration	1	N/A	N/A	New I/O	N/A
EN	23	RAS Pump 2 - Seal Leak	1	N/A	N/A	New I/O	N/A
EN	24	RAS Pump 2 - Temp Stator Phase 1	1	N/A	N/A	New I/O	N/A
EN	25	RAS Pump 2 - Temp Stator Phase 2	1	N/A	N/A	New I/O	N/A

<div>Programmable Logic Controller</div> <div>Appendix A - PLC Inputs/Outputs</div> <div>Nassau County Department of Public Works</div> <div>Cedar Creek WPCP Secondary Treatment Improvements</div>					Abbreviations		
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Partial Air Treatment Control Cabinet No. 1 I/O List (ATCC-1)							
EN	26	RAS Pump 2 - Temp Stator Phase 3	1	N/A	N/A	New I/O	N/A
EN	27	RAS Pump 2 - Temp Main Bearing	1	N/A	N/A	New I/O	N/A
EN	28	RAS Pump 2 - Temp Support Bearing	1	N/A	N/A	New I/O	N/A
EN	29	RAS Pump 2 - Total Starts	1	N/A	N/A	New I/O	N/A
EN	30	RAS Pump 2 - Service Time	1	N/A	N/A	New I/O	N/A
EN	31	RAS Pump 2 - AC Current	1	N/A	N/A	New I/O	N/A
EN	32	RAS Pump 2 - Vibration Total	1	N/A	N/A	New I/O	N/A
EN	33	RAS Pump 2 - Vibration X Dimension	1	N/A	N/A	New I/O	N/A
EN	34	RAS Pump 2 - Vibration Y Dimension	1	N/A	N/A	New I/O	N/A
EN	35	RAS Pump 2 - PTC/Thermistor	1	N/A	N/A	New I/O	N/A
EN	36	RAS Pump 2 - Leakage FLS1	1	N/A	N/A	New I/O	N/A
EN	37	RAS Pump 2 - Leakage FLS2	1	N/A	N/A	New I/O	N/A
EN	38	RAS Pump 2 - Leakage CLS (Water in Oil Sensor)	1	N/A	N/A	New I/O	N/A

Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements					Abbreviations		
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Partial Air Treatment Control Cabinet No. 2 I/O List (ATCC-2)							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
AI	1	Aeration Tank No. 4 Pass A DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40401
AI	2	Aeration Tank No. 4 Pass B DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40402
AI	3	Aeration Tank No. 4 Pass C DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40403
AI	4	Aeration Tank No. 4 Pass D DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40404
AI	5	Aeration Tank No. 5 Pass A DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40501
AI	6	Aeration Tank No. 5 Pass B DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40502
AI	7	Aeration Tank No. 5 Pass C DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40503
AI	8	Aeration Tank No. 5 Pass D DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40504
AI	9	Aeration Tank No. 6 Pass A DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40601
AI	10	Aeration Tank No. 6 Pass B DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40602
AI	11	Aeration Tank No. 6 Pass C DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40603
AI	12	Aeration Tank No. 6 Pass D DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40604
EN	1	Aeration Tank No. 4 Pass A Flow	1	TBD	GPM	Data Read to SCADA via CP45410 (Alternate No. 1)	FIT-45410
EN	2	Aeration Tank No. 4 Pass A Valve Control	1	0-100	%	Data Read to SCADA via CP45410 (Alternate No. 1)	CV-45410
EN	3	Aeration Tank No. 4 Pass A Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45410 (Alternate No. 1)	CV-45410
EN	4	Aeration Tank No. 4 Pass A Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45410-GRID (Alternate No. 2)	FIT-45411A
EN	5	Aeration Tank No. 4 Pass A Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45410-GRID (Alternate No. 2)	CV-LA141-2A
EN	6	Aeration Tank No. 4 Pass A Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45410-GRID (Alternate No. 2)	CV-LA141-2A
EN	7	Aeration Tank No. 4 Pass A Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45410-GRID (Alternate No. 2)	FIT-45411B
EN	8	Aeration Tank No. 4 Pass A Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45410-GRID (Alternate No. 2)	CV-LA141-2B
EN	9	Aeration Tank No. 4 Pass A Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45410-GRID (Alternate No. 2)	CV-LA141-2B
EN	10	Aeration Tank No. 4 Pass A Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45410-GRID (Alternate No. 2)	FIT-45411C
EN	11	Aeration Tank No. 4 Pass A Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45410-GRID (Alternate No. 2)	CV-LA141-2C
EN	12	Aeration Tank No. 4 Pass A Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45410-GRID (Alternate No. 2)	CV-LA141-2C
EN	13	Aeration Tank No. 4 Pass B Flow	1	TBD	GPM	Data Read to SCADA via CP45420 (Alternate No. 1)	FIT-45420
EN	14	Aeration Tank No. 4 Pass B Valve Control	1	0-100	%	Data Read to SCADA via CP45420 (Alternate No. 1)	CV-45420
EN	15	Aeration Tank No. 4 Pass B Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45420 (Alternate No. 1)	CV-45420
EN	16	Aeration Tank No. 4 Pass B Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45420-GRID (Alternate No. 2)	FIT-45411A
EN	17	Aeration Tank No. 4 Pass B Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45420-GRID (Alternate No. 2)	CV-LA142-2A
EN	18	Aeration Tank No. 4 Pass B Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45420-GRID (Alternate No. 2)	CV-LA142-2A
EN	19	Aeration Tank No. 4 Pass B Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45420-GRID (Alternate No. 2)	FIT-45411B
EN	20	Aeration Tank No. 4 Pass B Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45420-GRID (Alternate No. 2)	CV-LA142-2B
EN	21	Aeration Tank No. 4 Pass B Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45420-GRID (Alternate No. 2)	CV-LA142-2B
EN	22	Aeration Tank No. 4 Pass B Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45420-GRID (Alternate No. 2)	FIT-45411C
EN	23	Aeration Tank No. 4 Pass B Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45420-GRID (Alternate No. 2)	CV-LA142-2C
EN	24	Aeration Tank No. 4 Pass B Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45420-GRID (Alternate No. 2)	CV-LA142-2C



Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements					Abbreviations		
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Partial Air Treatment Control Cabinet No. 2 I/O List (ATCC-2)							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
EN	25	Aeration Tank No. 4 Pass C Flow	1	TBD	GPM	Data Read to SCADA via CP45430 (Alternate No. 1)	FIT-45430
EN	26	Aeration Tank No. 4 Pass C Valve Control	1	0-100	%	Data Read to SCADA via CP45430 (Alternate No. 1)	CV-45430
EN	27	Aeration Tank No. 4 Pass C Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45430 (Alternate No. 1)	CV-45430
EN	28	Aeration Tank No. 4 Pass C Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45430-GRID (Alternate No. 2)	FIT-45411A
EN	29	Aeration Tank No. 4 Pass C Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45430-GRID (Alternate No. 2)	CV-LA143-2A
EN	30	Aeration Tank No. 4 Pass C Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45430-GRID (Alternate No. 2)	CV-LA143-2A
EN	31	Aeration Tank No. 4 Pass C Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45430-GRID (Alternate No. 2)	FIT-45411B
EN	32	Aeration Tank No. 4 Pass C Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45430-GRID (Alternate No. 2)	CV-LA143-2B
EN	33	Aeration Tank No. 4 Pass C Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45430-GRID (Alternate No. 2)	CV-LA143-2B
EN	34	Aeration Tank No. 4 Pass C Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45430-GRID (Alternate No. 2)	FIT-45411C
EN	35	Aeration Tank No. 4 Pass C Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45430-GRID (Alternate No. 2)	CV-LA143-2C
EN	36	Aeration Tank No. 4 Pass C Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45430-GRID (Alternate No. 2)	CV-LA143-2C
EN	37	Aeration Tank No. 4 Pass D Flow	1	TBD	GPM	Data Read to SCADA via CP45440 (Alternate No. 1)	FIT-45440
EN	38	Aeration Tank No. 4 Pass D Valve Control	1	0-100	%	Data Read to SCADA via CP45440 (Alternate No. 1)	CV-45440
EN	39	Aeration Tank No. 4 Pass D Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45440 (Alternate No. 1)	CV-45440
EN	40	Aeration Tank No. 4 Pass D Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45440-GRID (Alternate No. 2)	FIT-45411A
EN	41	Aeration Tank No. 4 Pass D Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45440-GRID (Alternate No. 2)	CV-LA144-2A
EN	42	Aeration Tank No. 4 Pass D Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45440-GRID (Alternate No. 2)	CV-LA144-2A
EN	43	Aeration Tank No. 4 Pass D Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45440-GRID (Alternate No. 2)	FIT-45411B
EN	44	Aeration Tank No. 4 Pass D Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45440-GRID (Alternate No. 2)	CV-LA144-2B
EN	45	Aeration Tank No. 4 Pass D Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45440-GRID (Alternate No. 2)	CV-LA144-2B
EN	46	Aeration Tank No. 4 Pass D Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45440-GRID (Alternate No. 2)	FIT-45411C
EN	47	Aeration Tank No. 4 Pass D Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45440-GRID (Alternate No. 2)	CV-LA144-2C
EN	48	Aeration Tank No. 4 Pass D Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45440-GRID (Alternate No. 2)	CV-LA144-2C
EN	49	Aeration Tank No. 5 Pass A Flow	1	TBD	GPM	Data Read to SCADA via CP45510 (Alternate No. 1)	FIT-45510
EN	50	Aeration Tank No. 5 Pass A Valve Control	1	0-100	%	Data Read to SCADA via CP45510 (Alternate No. 1)	CV-45510
EN	51	Aeration Tank No. 5 Pass A Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45510 (Alternate No. 1)	CV-45510
EN	52	Aeration Tank No. 5 Pass A Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45510-GRID (Alternate No. 2)	FIT-45411A
EN	53	Aeration Tank No. 5 Pass A Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45510-GRID (Alternate No. 2)	CV-LA151-2A
EN	54	Aeration Tank No. 5 Pass A Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45510-GRID (Alternate No. 2)	CV-LA151-2A
EN	55	Aeration Tank No. 5 Pass A Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45510-GRID (Alternate No. 2)	FIT-45411B
EN	56	Aeration Tank No. 5 Pass A Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45510-GRID (Alternate No. 2)	CV-LA151-2B
EN	57	Aeration Tank No. 5 Pass A Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45510-GRID (Alternate No. 2)	CV-LA151-2B
EN	58	Aeration Tank No. 5 Pass A Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45510-GRID (Alternate No. 2)	FIT-45411C
EN	59	Aeration Tank No. 5 Pass A Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45510-GRID (Alternate No. 2)	CV-LA151-2C
EN	60	Aeration Tank No. 5 Pass A Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45510-GRID (Alternate No. 2)	CV-LA151-2C

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Partial Air Treatment Control Cabinet No. 2 I/O List (ATCC-2)							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
EN	61	Aeration Tank No. 5 Pass B Flow	1	TBD	GPM	Data Read to SCADA via CP45520 (Alternate No. 1)	FIT-45520
EN	62	Aeration Tank No. 5 Pass B Valve Control	1	0-100	%	Data Read to SCADA via CP45520 (Alternate No. 1)	CV-45520
EN	63	Aeration Tank No. 5 Pass B Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45520 (Alternate No. 1)	CV-45520
EN	64	Aeration Tank No. 5 Pass B Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45520-GRID (Alternate No. 2)	FIT-45411A
EN	65	Aeration Tank No. 5 Pass B Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45520-GRID (Alternate No. 2)	CV-LA152-2A
EN	66	Aeration Tank No. 5 Pass B Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45520-GRID (Alternate No. 2)	CV-LA152-2A
EN	67	Aeration Tank No. 5 Pass B Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45520-GRID (Alternate No. 2)	FIT-45411B
EN	68	Aeration Tank No. 5 Pass B Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45520-GRID (Alternate No. 2)	CV-LA152-2B
EN	69	Aeration Tank No. 5 Pass B Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45520-GRID (Alternate No. 2)	CV-LA152-2B
EN	70	Aeration Tank No. 5 Pass B Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45520-GRID (Alternate No. 2)	FIT-45411C
EN	71	Aeration Tank No. 5 Pass B Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45520-GRID (Alternate No. 2)	CV-LA152-2C
EN	72	Aeration Tank No. 5 Pass B Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45520-GRID (Alternate No. 2)	CV-LA152-2C

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Partial Air Treatment Control Cabinet No. 2 I/O List (ATCC-2)							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
EN	73	Aeration Tank No. 5 Pass C Flow	1	TBD	GPM	Data Read to SCADA via CP45530 (Alternate No. 1)	FIT-45530
EN	74	Aeration Tank No. 5 Pass C Valve Control	1	0-100	%	Data Read to SCADA via CP45530 (Alternate No. 1)	CV-45530
EN	75	Aeration Tank No. 5 Pass C Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45530 (Alternate No. 1)	CV-45530
EN	76	Aeration Tank No. 5 Pass C Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45530-GRID (Alternate No. 2)	FIT-45411A
EN	77	Aeration Tank No. 5 Pass C Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45530-GRID (Alternate No. 2)	CV-LA153-2A
EN	78	Aeration Tank No. 5 Pass C Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45530-GRID (Alternate No. 2)	CV-LA153-2A
EN	79	Aeration Tank No. 5 Pass C Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45530-GRID (Alternate No. 2)	FIT-45411B
EN	80	Aeration Tank No. 5 Pass C Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45530-GRID (Alternate No. 2)	CV-LA153-2B
EN	81	Aeration Tank No. 5 Pass C Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45530-GRID (Alternate No. 2)	CV-LA153-2B
EN	82	Aeration Tank No. 5 Pass C Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45530-GRID (Alternate No. 2)	FIT-45411C
EN	83	Aeration Tank No. 5 Pass C Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45530-GRID (Alternate No. 2)	CV-LA153-2C
EN	84	Aeration Tank No. 5 Pass C Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45530-GRID (Alternate No. 2)	CV-LA153-2C
EN	85	Aeration Tank No. 5 Pass D Flow	1	TBD	GPM	Data Read to SCADA via CP45540 (Alternate No. 1)	FIT-45540
EN	86	Aeration Tank No. 5 Pass D Valve Control	1	0-100	%	Data Read to SCADA via CP45540 (Alternate No. 1)	CV-45540
EN	87	Aeration Tank No. 5 Pass D Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45540 (Alternate No. 1)	CV-45540
EN	88	Aeration Tank No. 5 Pass D Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45540-GRID (Alternate No. 2)	FIT-45411A
EN	89	Aeration Tank No. 5 Pass D Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45540-GRID (Alternate No. 2)	CV-LA154-2A
EN	90	Aeration Tank No. 5 Pass D Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45540-GRID (Alternate No. 2)	CV-LA154-2A
EN	91	Aeration Tank No. 5 Pass D Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45540-GRID (Alternate No. 2)	FIT-45411B
EN	92	Aeration Tank No. 5 Pass D Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45540-GRID (Alternate No. 2)	CV-LA154-2B
EN	93	Aeration Tank No. 5 Pass D Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45540-GRID (Alternate No. 2)	CV-LA154-2B
EN	94	Aeration Tank No. 5 Pass D Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45540-GRID (Alternate No. 2)	FIT-45411C
EN	95	Aeration Tank No. 5 Pass D Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45540-GRID (Alternate No. 2)	CV-LA154-2C
EN	96	Aeration Tank No. 5 Pass D Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45540-GRID (Alternate No. 2)	CV-LA154-2C
EN	97	Aeration Tank No. 6 Pass A Flow	1	TBD	GPM	Data Read to SCADA via CP45610 (Alternate No. 1)	FIT-45610
EN	98	Aeration Tank No. 6 Pass A Valve Control	1	0-100	%	Data Read to SCADA via CP45610 (Alternate No. 1)	CV-45610
EN	99	Aeration Tank No. 6 Pass A Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45610 (Alternate No. 1)	CV-45610
EN	100	Aeration Tank No. 6 Pass A Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45610-GRID (Alternate No. 2)	FIT-45411A
EN	101	Aeration Tank No. 6 Pass A Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45610-GRID (Alternate No. 2)	CV-LA161-2A
EN	102	Aeration Tank No. 6 Pass A Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45610-GRID (Alternate No. 2)	CV-LA161-2A
EN	103	Aeration Tank No. 6 Pass A Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45610-GRID (Alternate No. 2)	FIT-45411B
EN	104	Aeration Tank No. 6 Pass A Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45610-GRID (Alternate No. 2)	CV-LA161-2B
EN	105	Aeration Tank No. 6 Pass A Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45610-GRID (Alternate No. 2)	CV-LA161-2B
EN	106	Aeration Tank No. 6 Pass A Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45610-GRID (Alternate No. 2)	FIT-45411C
EN	107	Aeration Tank No. 6 Pass A Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45610-GRID (Alternate No. 2)	CV-LA161-2C
EN	108	Aeration Tank No. 6 Pass A Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45610-GRID (Alternate No. 2)	CV-LA161-2C

Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements					Abbreviations		
					DI:	Digital Input	
					DO:	Digital Output	
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					AO:	Analog Output	
					MB:	Modbus	
					EN:	Ethernet	
Partial Air Treatment Control Cabinet No. 2 I/O List (ATCC-2)							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
EN	109	Aeration Tank No. 6 Pass B Flow	1	TBD	GPM	Data Read to SCADA via CP45620 (Alternate No. 1)	FIT-45620
EN	110	Aeration Tank No. 6 Pass B Valve Control	1	0-100	%	Data Read to SCADA via CP45620 (Alternate No. 1)	CV-45620
EN	111	Aeration Tank No. 6 Pass B Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45620 (Alternate No. 1)	CV-45620
EN	112	Aeration Tank No. 6 Pass B Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45620-GRID (Alternate No. 2)	FIT-45411A
EN	113	Aeration Tank No. 6 Pass B Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45620-GRID (Alternate No. 2)	CV-LA162-2A
EN	114	Aeration Tank No. 6 Pass B Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45620-GRID (Alternate No. 2)	CV-LA162-2A
EN	115	Aeration Tank No. 6 Pass B Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45620-GRID (Alternate No. 2)	FIT-45411B
EN	116	Aeration Tank No. 6 Pass B Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45620-GRID (Alternate No. 2)	CV-LA162-2B
EN	117	Aeration Tank No. 6 Pass B Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45620-GRID (Alternate No. 2)	CV-LA162-2B
EN	118	Aeration Tank No. 6 Pass B Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45620-GRID (Alternate No. 2)	FIT-45411C
EN	119	Aeration Tank No. 6 Pass B Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45620-GRID (Alternate No. 2)	CV-LA162-2C
EN	120	Aeration Tank No. 6 Pass B Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45620-GRID (Alternate No. 2)	CV-LA162-2C
EN	121	Aeration Tank No. 6 Pass C Flow	1	TBD	GPM	Data Read to SCADA via CP45630 (Alternate No. 1)	FIT-45630
EN	122	Aeration Tank No. 6 Pass C Valve Control	1	0-100	%	Data Read to SCADA via CP45630 (Alternate No. 1)	CV-45630
EN	123	Aeration Tank No. 6 Pass C Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45630 (Alternate No. 1)	CV-45630
EN	124	Aeration Tank No. 6 Pass C Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45630-GRID (Alternate No. 2)	FIT-45411A
EN	125	Aeration Tank No. 6 Pass C Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45630-GRID (Alternate No. 2)	CV-LA163-2A
EN	126	Aeration Tank No. 6 Pass C Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45630-GRID (Alternate No. 2)	CV-LA163-2A
EN	127	Aeration Tank No. 6 Pass C Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45630-GRID (Alternate No. 2)	FIT-45411B
EN	128	Aeration Tank No. 6 Pass C Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45630-GRID (Alternate No. 2)	CV-LA163-2B
EN	129	Aeration Tank No. 6 Pass C Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45630-GRID (Alternate No. 2)	CV-LA163-2B
EN	130	Aeration Tank No. 6 Pass C Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45630-GRID (Alternate No. 2)	FIT-45411C
EN	131	Aeration Tank No. 6 Pass C Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45630-GRID (Alternate No. 2)	CV-LA163-2C
EN	132	Aeration Tank No. 6 Pass C Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45630-GRID (Alternate No. 2)	CV-LA163-2C
EN	133	Aeration Tank No. 6 Pass D Flow	1	TBD	GPM	Data Read to SCADA via CP45640 (Alternate No. 1)	FIT-45640
EN	134	Aeration Tank No. 6 Pass D Valve Control	1	0-100	%	Data Read to SCADA via CP45640 (Alternate No. 1)	CV-45640
EN	135	Aeration Tank No. 6 Pass D Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45640 (Alternate No. 1)	CV-45640
EN	136	Aeration Tank No. 6 Pass D Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45640-GRID (Alternate No. 2)	FIT-45411A
EN	137	Aeration Tank No. 6 Pass D Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45640-GRID (Alternate No. 2)	CV-LA164-2A
EN	138	Aeration Tank No. 6 Pass D Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45640-GRID (Alternate No. 2)	CV-LA164-2A
EN	139	Aeration Tank No. 6 Pass D Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45640-GRID (Alternate No. 2)	FIT-45411B
EN	140	Aeration Tank No. 6 Pass D Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45640-GRID (Alternate No. 2)	CV-LA164-2B
EN	141	Aeration Tank No. 6 Pass D Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45640-GRID (Alternate No. 2)	CV-LA164-2B
EN	142	Aeration Tank No. 6 Pass D Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45640-GRID (Alternate No. 2)	FIT-45411C
EN	143	Aeration Tank No. 6 Pass D Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45640-GRID (Alternate No. 2)	CV-LA164-2C
EN	144	Aeration Tank No. 6 Pass D Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45640-GRID (Alternate No. 2)	CV-LA164-2C

Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements						Abbreviations	
						DI:	Digital Input
						DO:	Digital Output
						AI:	Analog Input
						AO:	Analog Output
						MB:	Modbus
						EN:	Ethernet
Partial FOCE-RASN (Air Treatment Control Cabinet No. 3 (ATCC-3)) I/O List							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
DI	1	Final Sedimentation Tank No. 1 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	2	Final Sedimentation Tank No. 1 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	3	Final Sedimentation Tank No. 1 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	4	Final Sedimentation Tank No. 2 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	5	Final Sedimentation Tank No. 2 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	6	Final Sedimentation Tank No. 2 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	7	Final Sedimentation Tank No. 3 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	8	Final Sedimentation Tank No. 3 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	9	Final Sedimentation Tank No. 3 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	10	Final Sedimentation Tank No. 4 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	11	Final Sedimentation Tank No. 4 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	12	Final Sedimentation Tank No. 4 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	13	Final Sedimentation Tank No. 5 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	14	Final Sedimentation Tank No. 5 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	15	Final Sedimentation Tank No. 5 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	16	Final Sedimentation Tank No. 6 - Drive Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	17	Final Sedimentation Tank No. 6 - High Torque	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	18	Final Sedimentation Tank No. 6 - Torque Overload	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	19	RAS-Pump 1 - Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	20	RAS-Pump 1 - Remote	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	21	RAS-Pump 1 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DI	22	RAS-Pump 1 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DI	23	RAS-Pump 1 - Fault	1	N/A	N/A	New I/O	N/A
DI	24	RAS-Pump 2 - Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	25	RAS-Pump 2 - Remote	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	26	RAS-Pump 2 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DI	27	RAS-Pump 2 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DI	28	RAS-Pump 2 - Fault	1	N/A	N/A	New I/O	N/A
DI	29	RAS-Pump 3 - Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	30	RAS-Pump 3 - Remote	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	31	RAS-Pump 3 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DI	32	RAS-Pump 3 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DI	33	RAS-Pump 3 - Fault	1	N/A	N/A	New I/O	N/A
DI	34	RAS-Pump 4 - Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	35	RAS-Pump 4 - Remote	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	36	RAS-Pump 4 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DI	37	RAS-Pump 4 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A

<div> <div>Programmable Logic Controller</div> <div>Appendix A - PLC Inputs/Outputs</div> <div>Nassau County Department of Public Works</div> <div>Cedar Creek WPCP Secondary Treatment Improvements</div> </div>						Abbreviations	
						DI:	Digital Input
						DO:	Digital Output
						AI:	Analog Input
						AO:	Analog Output
						MB:	Modbus
						EN:	Ethernet
Partial FOCE-RASN (Air Treatment Control Cabinet No. 3 (ATCC-3)) I/O List							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
DI	38	RAS-Pump 4 - Fault	1	N/A	N/A	New I/O	N/A
DI	39	RAS-Pump 5 - Running	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	40	RAS-Pump 5 - Remote	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DI	41	RAS-Pump 5 - High Discharge Pressure	1	N/A	N/A	New I/O	N/A
DI	42	RAS-Pump 5 - Low Suction Pressure	1	N/A	N/A	New I/O	N/A
DI	43	RAS-Pump 5 - Fault	1	N/A	N/A	New I/O	N/A
DI	44	RAS Flow From Final Tank No. 1 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51011
DI	45	RAS Flow From Final Tank No. 2 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51021
DI	46	RAS Flow From Final Tank No. 3 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51031
DI	47	RAS Flow From Final Tank No. 4 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51041
DI	48	RAS Flow From Final Tank No. 5 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51051
DI	49	RAS Flow From Final Tank No. 6 - Pneumatic Valve Limit Switch	1	N/A	N/A	New I/O	CV-51061
DO	1	RAS-Pump 1 - Start/Stop	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DO	2	RAS-Pump 2 - Start/Stop	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DO	3	RAS-Pump 3 - Start/Stop	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DO	4	RAS-Pump 4 - Start/Stop	1	N/A	N/A	Existing I/O to be Re-Used	N/A
DO	5	RAS-Pump 5 - Start/Stop	1	N/A	N/A	Existing I/O to be Re-Used	N/A
AI	1	Waste Activated Sludge Pump No. 1 Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-52016
AI	2	Waste Activated Sludge Pump No. 1 Pressure	1	TBD	psi	New I/O	PIT-52016
AI	2	Waste Activated Sludge Pump No. 2 Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-52026
AI	3	Waste Activated Sludge Pump No. 2 Pressure	1	TBD	psi	New I/O	PIT-52026
AI	4	Waste Activated Sludge Pump No. 3 Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-52036
AI	5	Waste Activated Sludge Pump No. 3 Pressure	1	TBD	psi	New I/O	PIT-52036
AI	6	Waste Activated Sludge Pump No. 4 Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-52046
AI	7	Waste Activated Sludge Pump No. 4 Pressure	1	TBD	psi	New I/O	PIT-52046
AI	8	Final Sedimentation Tank No. 1 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50011
AI	9	Final Sedimentation Tank No. 1 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50011
AI	10	Final Sedimentation Tank No. 1 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51011
AI	11	Final Sedimentation Tank No. 2 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50021
AI	12	Final Sedimentation Tank No. 2 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50021
AI	13	Final Sedimentation Tank No. 2 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51021
AI	14	Final Sedimentation Tank No. 3 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50031
AI	15	Final Sedimentation Tank No. 3 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50031
AI	16	Final Sedimentation Tank No. 3 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51031
AI	17	Final Sedimentation Tank No. 4 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50041
AI	18	Final Sedimentation Tank No. 4 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50041
AI	19	Final Sedimentation Tank No. 4 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51041

Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements					Abbreviations		
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					EN:	Ethernet	
Partial FOCE-RASN (Air Treatment Control Cabinet No. 3 (ATCC-3)) I/O List							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
AI	20	Final Sedimentation Tank No. 5 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50051
AI	21	Final Sedimentation Tank No. 5 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50051
AI	22	Final Sedimentation Tank No. 5 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51051
AI	23	Final Sedimentation Tank No. 6 Influent Flow	1	TBD	GPM	Existing I/O to be Re-Used	CV-50061
AI	24	Final Sedimentation Tank No. 6 Influent Valve Position Feedback	1	0-100	%	New I/O	FIT-50061
AI	25	Final Sedimentation Tank No. 6 Return Activated Sludge Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51061
AI	26	Return Activated Sludge to Aeration Tank 1 Pass A Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51401
AI	27	Return Activated Sludge to Aeration Tank 1 Pass C Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT51403
AI	28	Return Activated Sludge to Aeration Tank 2 Pass A Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51501
AI	29	Return Activated Sludge to Aeration Tank 2 Pass C Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT51503
AI	30	Return Activated Sludge to Aeration Tank 3 Pass A Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT-51601
AI	31	Return Activated Sludge to Aeration Tank 3 Pass C Flow	1	TBD	GPM	Existing I/O to be Re-Used	FIT51603
AI	32	RAS-Pump 1 - Speed Reference	1	0-100	%	Existing I/O to be Re-Used	SI-51514
AI	33	RAS-Pump 1 - Suction Pressure	1	TBD	PSI	New I/O	PIT-51901-A
AI	34	RAS-Pump 1 - Discharge Pressure	1	TBD	PSI	New I/O	PIT-51901-B
AI	35	RAS-Pump 2 - Speed Reference	1	0-100	%	Existing I/O to be Re-Used	SI-51524
AI	36	RAS-Pump 2 - Suction Pressure	1	TBD	PSI	New I/O	PIT-51902-A
AI	37	RAS-Pump 2 - Discharge Pressure	1	TBD	PSI	New I/O	PIT-51902-B
AI	38	RAS-Pump 3 - Speed Reference	1	0-100	%	Existing I/O to be Re-Used	SI-51534
AI	39	RAS-Pump 3 - Suction Pressure	1	TBD	PSI	New I/O	PIT-51903-A
AI	40	RAS-Pump 3 - Discharge Pressure	1	TBD	PSI	New I/O	PIT-51903-B
AI	41	RAS-Pump 4 - Speed Reference	1	0-100	%	Existing I/O to be Re-Used	SI-51544
AI	42	RAS-Pump 4 - Suction Pressure	1	TBD	PSI	New I/O	PIT-51904-A
AI	43	RAS-Pump 4 - Discharge Pressure	1	TBD	PSI	New I/O	PIT-51904-B
AI	44	RAS-Pump 5 - Speed Reference	1	0-100	%	Existing I/O to be Re-Used	SI-51554
AI	45	RAS-Pump 5 - Suction Pressure	1	TBD	PSI	New I/O	PIT-51905-A
AI	46	RAS-Pump 5 - Discharge Pressure	1	TBD	PSI	New I/O	PIT-51905-B
AI	47	RAS Flow From Final Tank No. 1 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51011
AI	48	RAS Flow From Final Tank No. 2 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51021
AI	49	RAS Flow From Final Tank No. 3 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51031
AI	50	RAS Flow From Final Tank No. 4 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51041
AI	51	RAS Flow From Final Tank No. 5 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51051
AI	52	RAS Flow From Final Tank No. 6 - Pneumatic Valve Feedback Transmitter	1	0-100	%	New I/O	CV-51061
AO	1	Final Sedimentation Tank No. 1 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50011
AO	2	Final Sedimentation Tank No. 2 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50021

<div>Programmable Logic Controller</div> <div>Appendix A - PLC Inputs/Outputs</div> <div>Nassau County Department of Public Works</div> <div>Cedar Creek WPCP Secondary Treatment Improvements</div>					Abbreviations		
					DI:	Digital Input	
					DO:	Digital Output	
					AI:	Analog Input	
					AO:	Analog Output	
					MB:	Modbus	
					EN:	Ethernet	
Partial FOCE-RASN (Air Treatment Control Cabinet No. 3 (ATCC-3)) I/O List							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
AO	3	Final Sedimentation Tank No. 3 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50031
AO	4	Final Sedimentation Tank No. 4 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50041
AO	5	Final Sedimentation Tank No. 5 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50051
AO	6	Final Sedimentation Tank No. 6 Influent Valve Control	1	0-100	%	Existing I/O to be Re-Used	FIT-50061
AO	7	RAS-Pump 1 - Speed Command	1	0-100	%	Existing I/O to be Re-Used	SIC-51514



Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements					Abbreviations		
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					AO:	Analog Output	
					MB:	Modbus	
					EN:	Ethernet	
Partial Air Treatment Control Cabinet No. 4 I/O List (ATCC4)							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
AI	1	Aeration Tank No. 1 Pass A DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40101
AI	2	Aeration Tank No. 1 Pass B DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40102
AI	3	Aeration Tank No. 1 Pass C DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40103
AI	4	Aeration Tank No. 1 Pass D DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40104
AI	5	Aeration Tank No. 2 Pass A DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40201
AI	6	Aeration Tank No. 2 Pass B DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40202
AI	7	Aeration Tank No. 2 Pass C DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40203
AI	8	Aeration Tank No. 2 Pass D DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40204
AI	9	Aeration Tank No. 3 Pass A DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40301
AI	10	Aeration Tank No. 3 Pass B DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40302
AI	11	Aeration Tank No. 3 Pass C DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40303
AI	12	Aeration Tank No. 3 Pass D DO Sensor Level	1	TBD	TBD	Existing I/O to be Re-Used (Alternate No. 1)	AE-40304
EN	1	Aeration Tank No. 1 Pass A Flow	1	TBD	GPM	Data Read to SCADA via CP45110 (Alternate No. 1)	FIT-45110
EN	2	Aeration Tank No. 1 Pass A Valve Control	1	0-100	%	Data Read to SCADA via CP45110 (Alternate No. 1)	CV-45110
EN	3	Aeration Tank No. 1 Pass A Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45110 (Alternate No. 1)	CV-45110
EN	4	Aeration Tank No. 1 Pass A Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45110-GRID (Alternate No. 2)	FIT-45111
EN	5	Aeration Tank No. 1 Pass A Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45110-GRID (Alternate No. 2)	CV-45110-A
EN	6	Aeration Tank No. 1 Pass A Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45110-GRID (Alternate No. 2)	CV-45110-A
EN	7	Aeration Tank No. 1 Pass A Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45110-GRID (Alternate No. 2)	FIT-45112
EN	8	Aeration Tank No. 1 Pass A Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45110-GRID (Alternate No. 2)	CV-45110-B
EN	9	Aeration Tank No. 1 Pass A Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45110-GRID (Alternate No. 2)	CV-45110-B
EN	10	Aeration Tank No. 1 Pass A Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45110-GRID (Alternate No. 2)	FIT-45113
EN	11	Aeration Tank No. 1 Pass A Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45110-GRID (Alternate No. 2)	CV-45110-C
EN	12	Aeration Tank No. 1 Pass A Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45110-GRID (Alternate No. 2)	CV-45110-C
EN	13	Aeration Tank No. 1 Pass B Flow	1	TBD	GPM	Data Read to SCADA via CP45120 (Alternate No. 1)	FIT-45120
EN	14	Aeration Tank No. 1 Pass B Valve Control	1	0-100	%	Data Read to SCADA via CP45120 (Alternate No. 1)	CV-45120
EN	15	Aeration Tank No. 1 Pass B Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45120 (Alternate No. 1)	CV-45120
EN	16	Aeration Tank No. 1 Pass B Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45120-GRID (Alternate No. 2)	FIT-45121
EN	17	Aeration Tank No. 1 Pass B Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45120-GRID (Alternate No. 2)	CV-45120-A
EN	18	Aeration Tank No. 1 Pass B Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45120-GRID (Alternate No. 2)	CV-45120-A
EN	19	Aeration Tank No. 1 Pass B Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45120-GRID (Alternate No. 2)	FIT-45122
EN	20	Aeration Tank No. 1 Pass B Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45120-GRID (Alternate No. 2)	CV-45120-B
EN	21	Aeration Tank No. 1 Pass B Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45120-GRID (Alternate No. 2)	CV-45120-B
EN	22	Aeration Tank No. 1 Pass B Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45120-GRID (Alternate No. 2)	FIT-45123
EN	23	Aeration Tank No. 1 Pass B Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45120-GRID (Alternate No. 2)	CV-45120-C
EN	24	Aeration Tank No. 1 Pass B Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45120-GRID (Alternate No. 2)	CV-45120-C

Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements					Abbreviations		
					DI:	Digital Input	
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					AO:	Analog Output	
					MB:	Modbus	
					EN:	Ethernet	
Partial Air Treatment Control Cabinet No. 4 I/O List (ATCC4)							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
EN	25	Aeration Tank No. 1 Pass C Flow	1	TBD	GPM	Data Read to SCADA via CP45130 (Alternate No. 1)	FIT-45130
EN	26	Aeration Tank No. 1 Pass C Valve Control	1	0-100	%	Data Read to SCADA via CP45130 (Alternate No. 1)	CV-45130
EN	27	Aeration Tank No. 1 Pass C Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45130 (Alternate No. 1)	CV-45130
EN	28	Aeration Tank No. 1 Pass C Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45130-GRID (Alternate No. 2)	FIT-45131
EN	29	Aeration Tank No. 1 Pass C Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45130-GRID (Alternate No. 2)	CV-45130-A
EN	30	Aeration Tank No. 1 Pass C Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45130-GRID (Alternate No. 2)	CV-45130-A
EN	31	Aeration Tank No. 1 Pass C Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45130-GRID (Alternate No. 2)	FIT-45132
EN	32	Aeration Tank No. 1 Pass C Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45130-GRID (Alternate No. 2)	CV-45130-B
EN	33	Aeration Tank No. 1 Pass C Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45130-GRID (Alternate No. 2)	CV-45130-B
EN	34	Aeration Tank No. 1 Pass C Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45130-GRID (Alternate No. 2)	FIT-45133
EN	35	Aeration Tank No. 1 Pass C Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45130-GRID (Alternate No. 2)	CV-45130-C
EN	36	Aeration Tank No. 1 Pass C Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45130-GRID (Alternate No. 2)	CV-45130-C
EN	37	Aeration Tank No. 1 Pass D Flow	1	TBD	GPM	Data Read to SCADA via CP45140 (Alternate No. 1)	FIT-45140
EN	38	Aeration Tank No. 1 Pass D Valve Control	1	0-100	%	Data Read to SCADA via CP45140 (Alternate No. 1)	CV-45140
EN	39	Aeration Tank No. 1 Pass D Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45140 (Alternate No. 1)	CV-45140
EN	40	Aeration Tank No. 1 Pass D Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45140-GRID (Alternate No. 2)	FIT-45141
EN	41	Aeration Tank No. 1 Pass D Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45140-GRID (Alternate No. 2)	CV-45140-A
EN	42	Aeration Tank No. 1 Pass D Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45140-GRID (Alternate No. 2)	CV-45140-A
EN	43	Aeration Tank No. 1 Pass D Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45140-GRID (Alternate No. 2)	FIT-45142
EN	44	Aeration Tank No. 1 Pass D Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45140-GRID (Alternate No. 2)	CV-45140-B
EN	45	Aeration Tank No. 1 Pass D Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45140-GRID (Alternate No. 2)	CV-45140-B
EN	46	Aeration Tank No. 1 Pass D Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45140-GRID (Alternate No. 2)	FIT-45143
EN	47	Aeration Tank No. 1 Pass D Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45140-GRID (Alternate No. 2)	CV-45140-C
EN	48	Aeration Tank No. 1 Pass D Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45140-GRID (Alternate No. 2)	CV-45140-C
EN	49	Aeration Tank No. 2 Pass A Flow	1	TBD	GPM	Data Read to SCADA via CP45210 (Alternate No. 1)	FIT-45210
EN	50	Aeration Tank No. 2 Pass A Valve Control	1	0-100	%	Data Read to SCADA via CP45210 (Alternate No. 1)	CV-45210
EN	51	Aeration Tank No. 2 Pass A Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45210 (Alternate No. 1)	CV-45210
EN	52	Aeration Tank No. 2 Pass A Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45210-GRID (Alternate No. 2)	FIT-45211
EN	53	Aeration Tank No. 2 Pass A Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45210-GRID (Alternate No. 2)	CV-45210-A
EN	54	Aeration Tank No. 2 Pass A Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45210-GRID (Alternate No. 2)	CV-45210-A
EN	55	Aeration Tank No. 2 Pass A Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45210-GRID (Alternate No. 2)	FIT-45212
EN	56	Aeration Tank No. 2 Pass A Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45210-GRID (Alternate No. 2)	CV-45210-B
EN	57	Aeration Tank No. 2 Pass A Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45210-GRID (Alternate No. 2)	CV-45210-B
EN	58	Aeration Tank No. 2 Pass A Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45210-GRID (Alternate No. 2)	FIT-45213
EN	59	Aeration Tank No. 2 Pass A Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45210-GRID (Alternate No. 2)	CV-45210-C
EN	60	Aeration Tank No. 2 Pass A Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45210-GRID (Alternate No. 2)	CV-45210-C

Programmable Logic Controller Appendix A - PLC Inputs/Outputs Nassau County Department of Public Works Cedar Creek WPCP Secondary Treatment Improvements					Abbreviations		
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Partial Air Treatment Control Cabinet No. 4 I/O List (ATCC4)							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
EN	61	Aeration Tank No. 2 Pass B Flow	1	TBD	GPM	Data Read to SCADA via CP45220 (Alternate No. 1)	FIT-45220
EN	62	Aeration Tank No. 2 Pass B Valve Control	1	0-100	%	Data Read to SCADA via CP45220 (Alternate No. 1)	CV-45220
EN	63	Aeration Tank No. 2 Pass B Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45220 (Alternate No. 1)	CV-45220
EN	64	Aeration Tank No. 2 Pass B Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45220-GRID (Alternate No. 2)	FIT-45221
EN	65	Aeration Tank No. 2 Pass B Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45220-GRID (Alternate No. 2)	CV-45220-A
EN	66	Aeration Tank No. 2 Pass B Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45220-GRID (Alternate No. 2)	CV-45220-A
EN	67	Aeration Tank No. 2 Pass B Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45220-GRID (Alternate No. 2)	FIT-45222
EN	68	Aeration Tank No. 2 Pass B Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45220-GRID (Alternate No. 2)	CV-45220-B
EN	69	Aeration Tank No. 2 Pass B Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45220-GRID (Alternate No. 2)	CV-45220-B
EN	70	Aeration Tank No. 2 Pass B Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45220-GRID (Alternate No. 2)	FIT-45223
EN	71	Aeration Tank No. 2 Pass B Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45220-GRID (Alternate No. 2)	CV-45220-C
EN	72	Aeration Tank No. 2 Pass B Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45220-GRID (Alternate No. 2)	CV-45220-C
EN	73	Aeration Tank No. 2 Pass C Flow	1	TBD	GPM	Data Read to SCADA via CP45230 (Alternate No. 1)	FIT-45230
EN	74	Aeration Tank No. 2 Pass C Valve Control	1	0-100	%	Data Read to SCADA via CP45230 (Alternate No. 1)	CV-45230
EN	75	Aeration Tank No. 2 Pass C Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45230 (Alternate No. 1)	CV-45230
EN	76	Aeration Tank No. 2 Pass C Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45230-GRID (Alternate No. 2)	FIT-45231
EN	77	Aeration Tank No. 2 Pass C Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45230-GRID (Alternate No. 2)	CV-45230-A
EN	78	Aeration Tank No. 2 Pass C Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45230-GRID (Alternate No. 2)	CV-45230-A
EN	79	Aeration Tank No. 2 Pass C Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45230-GRID (Alternate No. 2)	FIT-45232
EN	80	Aeration Tank No. 2 Pass C Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45230-GRID (Alternate No. 2)	CV-45230-B
EN	81	Aeration Tank No. 2 Pass C Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45230-GRID (Alternate No. 2)	CV-45230-B
EN	82	Aeration Tank No. 2 Pass C Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45230-GRID (Alternate No. 2)	FIT-45233
EN	83	Aeration Tank No. 2 Pass C Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45230-GRID (Alternate No. 2)	CV-45230-C
EN	84	Aeration Tank No. 2 Pass C Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45230-GRID (Alternate No. 2)	CV-45230-C
EN	85	Aeration Tank No. 2 Pass D Flow	1	TBD	GPM	Data Read to SCADA via CP45240 (Alternate No. 1)	FIT-45240
EN	86	Aeration Tank No. 2 Pass D Valve Control	1	0-100	%	Data Read to SCADA via CP45240 (Alternate No. 1)	CV-45240
EN	87	Aeration Tank No. 2 Pass D Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45240 (Alternate No. 1)	CV-45240
EN	88	Aeration Tank No. 2 Pass D Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45240-GRID (Alternate No. 2)	FIT-45241
EN	89	Aeration Tank No. 2 Pass D Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45240-GRID (Alternate No. 2)	CV-45240-A
EN	90	Aeration Tank No. 2 Pass D Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45240-GRID (Alternate No. 2)	CV-45240-A
EN	91	Aeration Tank No. 2 Pass D Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45240-GRID (Alternate No. 2)	FIT-45242
EN	92	Aeration Tank No. 2 Pass D Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45240-GRID (Alternate No. 2)	CV-45240-B
EN	93	Aeration Tank No. 2 Pass D Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45240-GRID (Alternate No. 2)	CV-45240-B
EN	94	Aeration Tank No. 2 Pass D Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45240-GRID (Alternate No. 2)	FIT-45243
EN	95	Aeration Tank No. 2 Pass D Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45240-GRID (Alternate No. 2)	CV-45240-C
EN	96	Aeration Tank No. 2 Pass D Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45240-GRID (Alternate No. 2)	CV-45240-C

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					DI:	Digital Input	
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					AO:	Analog Output	
					MB:	Modbus	
					EN:	Ethernet	
Partial Air Treatment Control Cabinet No. 4 I/O List (ATCC4)							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
EN	97	Aeration Tank No. 3 Pass A Flow	1	TBD	GPM	Data Read to SCADA via CP45310 (Alternate No. 1)	FIT-45310
EN	98	Aeration Tank No. 3 Pass A Valve Control	1	0-100	%	Data Read to SCADA via CP45310 (Alternate No. 1)	CV-45310
EN	99	Aeration Tank No. 3 Pass A Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45310 (Alternate No. 1)	CV-45310
EN	100	Aeration Tank No. 3 Pass A Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45310-GRID (Alternate No. 2)	FIT-45311
EN	101	Aeration Tank No. 3 Pass A Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45310-GRID (Alternate No. 2)	CV-45310-A
EN	102	Aeration Tank No. 3 Pass A Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45310-GRID (Alternate No. 2)	CV-45310-A
EN	103	Aeration Tank No. 3 Pass A Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45310-GRID (Alternate No. 2)	FIT-45312
EN	104	Aeration Tank No. 3 Pass A Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45310-GRID (Alternate No. 2)	CV-45310-B
EN	105	Aeration Tank No. 3 Pass A Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45310-GRID (Alternate No. 2)	CV-45310-B
EN	106	Aeration Tank No. 3 Pass A Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45310-GRID (Alternate No. 2)	FIT-45313
EN	107	Aeration Tank No. 3 Pass A Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45310-GRID (Alternate No. 2)	CV-45310-C
EN	108	Aeration Tank No. 3 Pass A Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45310-GRID (Alternate No. 2)	CV-45310-C
EN	109	Aeration Tank No. 3 Pass B Flow	1	TBD	GPM	Data Read to SCADA via CP45320 (Alternate No. 1)	FIT-45320
EN	110	Aeration Tank No. 3 Pass B Valve Control	1	0-100	%	Data Read to SCADA via CP45320 (Alternate No. 1)	CV-45320
EN	111	Aeration Tank No. 3 Pass B Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45320 (Alternate No. 1)	CV-45320
EN	112	Aeration Tank No. 3 Pass B Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45320-GRID (Alternate No. 2)	FIT-45321
EN	113	Aeration Tank No. 3 Pass B Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45320-GRID (Alternate No. 2)	CV-45320-A
EN	114	Aeration Tank No. 3 Pass B Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45320-GRID (Alternate No. 2)	CV-45320-A
EN	115	Aeration Tank No. 3 Pass B Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45320-GRID (Alternate No. 2)	FIT-45322
EN	116	Aeration Tank No. 3 Pass B Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45320-GRID (Alternate No. 2)	CV-45320-B
EN	117	Aeration Tank No. 3 Pass B Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45320-GRID (Alternate No. 2)	CV-45320-B
EN	118	Aeration Tank No. 3 Pass B Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45320-GRID (Alternate No. 2)	FIT-45323
EN	119	Aeration Tank No. 3 Pass B Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45320-GRID (Alternate No. 2)	CV-45320-C
EN	120	Aeration Tank No. 3 Pass B Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45320-GRID (Alternate No. 2)	CV-45320-C
EN	121	Aeration Tank No. 3 Pass C Flow	1	TBD	GPM	Data Read to SCADA via CP45330 (Alternate No. 1)	FIT-45330
EN	122	Aeration Tank No. 3 Pass C Valve Control	1	0-100	%	Data Read to SCADA via CP45330 (Alternate No. 1)	CV-45330
EN	123	Aeration Tank No. 3 Pass C Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45330 (Alternate No. 1)	CV-45330
EN	124	Aeration Tank No. 3 Pass C Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45330-GRID (Alternate No. 2)	FIT-45331
EN	125	Aeration Tank No. 3 Pass C Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45330-GRID (Alternate No. 2)	CV-45330-A
EN	126	Aeration Tank No. 3 Pass C Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45330-GRID (Alternate No. 2)	CV-45330-A
EN	127	Aeration Tank No. 3 Pass C Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45330-GRID (Alternate No. 2)	FIT-45332
EN	128	Aeration Tank No. 3 Pass C Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45330-GRID (Alternate No. 2)	CV-45330-B
EN	129	Aeration Tank No. 3 Pass C Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45330-GRID (Alternate No. 2)	CV-45330-B
EN	130	Aeration Tank No. 3 Pass C Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45330-GRID (Alternate No. 2)	FIT-45333
EN	131	Aeration Tank No. 3 Pass C Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45330-GRID (Alternate No. 2)	CV-45330-C
EN	132	Aeration Tank No. 3 Pass C Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45330-GRID (Alternate No. 2)	CV-45330-C

<div>Programmable Logic Controller</div> <div>Appendix A - PLC Inputs/Outputs</div> <div>Nassau County Department of Public Works</div> <div>Cedar Creek WPCP Secondary Treatment Improvements</div>					Abbreviations		
					DI:	Digital Input	
					DO:	Digital Output	
					AI:	Analog Input	
					AO:	Analog Output	
					MB:	Modbus	
					EN:	Ethernet	
Partial Air Treatment Control Cabinet No. 4 I/O List (ATCC4)							
Signal Type	No.	Description	Quantity	Range	Units	Notes	Symbolic Address
EN	133	Aeration Tank No. 3 Pass D Flow	1	TBD	GPM	Data Read to SCADA via CP45340 (Alternate No. 1)	FIT-45340
EN	134	Aeration Tank No. 3 Pass D Valve Control	1	0-100	%	Data Read to SCADA via CP45340 (Alternate No. 1)	CV-45340
EN	135	Aeration Tank No. 3 Pass D Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45340 (Alternate No. 1)	CV-45340
EN	136	Aeration Tank No. 3 Pass D Grid 1 Flow	1	TBD	GPM	Data Read to SCADA via CP45340-GRID (Alternate No. 2)	FIT-45341
EN	137	Aeration Tank No. 3 Pass D Grid 1 Valve Control	1	0-100	%	Data Read to SCADA via CP45340-GRID (Alternate No. 2)	CV-45340-A
EN	138	Aeration Tank No. 3 Pass D Grid 1 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45340-GRID (Alternate No. 2)	CV-45340-A
EN	139	Aeration Tank No. 3 Pass D Grid 2 Flow	1	TBD	GPM	Data Read to SCADA via CP45340-GRID (Alternate No. 2)	FIT-45342
EN	140	Aeration Tank No. 3 Pass D Grid 2 Valve Control	1	0-100	%	Data Read to SCADA via CP45340-GRID (Alternate No. 2)	CV-45340-B
EN	141	Aeration Tank No. 3 Pass D Grid 2 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45340-GRID (Alternate No. 2)	CV-45340-B
EN	142	Aeration Tank No. 3 Pass D Grid 3 Flow	1	TBD	GPM	Data Read to SCADA via CP45340-GRID (Alternate No. 2)	FIT-45343
EN	143	Aeration Tank No. 3 Pass D Grid 3 Valve Control	1	0-100	%	Data Read to SCADA via CP45340-GRID (Alternate No. 2)	CV-45340-C
EN	144	Aeration Tank No. 3 Pass D Grid 3 Valve Position Feedback	1	0-100	%	Data Read to SCADA via CP45340-GRID (Alternate No. 2)	CV-45340-C

PART 1 - GENERAL

1.01 - 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. 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 and the Contractor.

B. Related Sections:

1. Section 13401 Process Control System General Provisions.
2. Section 13420 Primary Sensors and Field Instruments

C. This Section describes all of 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 bumpless, 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 an 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.

- e. For analog control loops, when control of field equipment is not in "COMPUTER," the associated PID controller output shall track the position feedback.
  - f. 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.
  - g. For all analog level 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 percent 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 data base.
  - 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 Owner to interrupt any sequence, loop or automatic operation and operate the same manually through the Operator Workstation.
- 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 manufacturer testing prior to delivery to site and finally during start-up.
- G. 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 Owner.
- H. Plant Power Failure: Plant equipment controlled by the control system shall be programmed to automatically reset upon failure.
- I. Restart: All equipment and motors shall be automatically restarted after power failure by the control system in an orderly fashion approved by the Engineer.
- J. 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.

#### 1.02 - 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 DCU. 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 (NOT USED)

#### PART 3 - EXECUTION

##### 3.01 - 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.

### 3.02 – LOW PRESSURE AIR PASS CONTROL PANELS

- A. Control of low pressure air pass actuated control valve with flow meter, dissolved oxygen sensor and valve position at each aeration tank pass. The main control protocols shall be as following:
  - 1. Each pass valve is to be controlled by its dedicated “LOCAL-REMOTE” selector switch.
  - 2. In the “LOCAL” position, the valve shall be modulated by the operator input at the local control station to reach the desired oxygen level in the aeration tank pass as measured by the applicable dissolved oxygen sensor and pass flow meter.
  - 3. In the “REMOTE” position, the valve shall be modulated by the operator input remotely via SCADA system to reach the desired oxygen level in the aeration tank pass as measured by the applicable dissolved oxygen sensor and pass flow meter.

### 3.03 – LOW PRESSURE AIR GRID CONTROL PANELS

- A. Control of low pressure air grid actuated control valves with flow meters and valve position at each aeration tank grid. The main control protocols shall be as following:
  - 1. Each grid valve is to be controlled by its dedicated “LOCAL-REMOTE” selector switch.
  - 2. In the “LOCAL” position, the valves shall be modulated by the operator input at the local control station to reach the desired oxygen level in the aeration tank pass as measured by the applicable dissolved oxygen sensor per pass and grid flow meters.
  - 3. In the “REMOTE” position, the valve shall be modulated by the operator input remotely via SCADA system to reach the desired oxygen level in the aeration tank grids as measured by the applicable dissolved oxygen sensor and grid flow meters.

### 3.04 - CONTROL FUNCTION DEFINITIONS AND GENERAL CRITERIA

- A. The hardware and/or software functions noted by this paragraph reference are to be implemented by the PLC/OIT control system specified herein.
- B. Any interlocks that are represented, before the local operational descriptions, or are stated as hardwired interlocks, shall interlock all the controls locally OIT.
- C. Any interlocks that are represented in a particular layer of the operational descriptions, shall interlock all the controls in that layer and the layer after it. However the interlock shall not interlock the commands in the layer before it.
- D. Any motor that is requested to start by an operator or an automatic program shall alarm if the run confirm status for that motor does not activate within two seconds. If a motor stops by an interlock or stops without any operator intervention, then that motor shall go into alarm. Any motors that are stopped by a program or the operator shall not go into an alarm.
- E. Motors with VFD controls shall be provided with GUI adjustable minimum and maximum speed setpoints. If the VFD is used in a PID control loop, the output of the controller shall not fall below or exceed the minimum and maximum speed setpoints, except where explicitly stated in the detailed control descriptions below.

- F. Motors that have an H/O/A shall indicate to the operator that the motor is being run in the "Hand" position. A motor is being run in "Hand" when the "Auto" position is not true, and the run confirm status is true. If not in "Auto" the PLC shall open up its output, contact to stop (shutdown) the pump.
- G. When an analog signal goes outside the 4-20 mA range due to a failure at the instrument or PLC card, the following shall take place:
  - 1. Alarm the signal at any local OITs.
  - 2. If the analog signal is associated with a control loop or ratio control loop that loop shall go into manual.
  - 3. If the analog signal is used in a calculation, that calculation shall use the last good analog signal. The computer shall place the control loop in manual if using the calculation.
- H. All interlocks that shutdown (Stop a piece of equipment and prevent it from being restarted or moved) shall be shown on the faceplate pop-up graphic for that piece of equipment.
- I. The run confirms or on status of all motors and lamps shall be accumulated to calculate a run time status of the equipment on the OIT graphic. Each run time accumulation shall come with a reset button on the HMI screen.
  - 1. Current Day's Runtime in XX.XX Hrs
  - 2. Yesterday's Runtime in XX.XX Hrs
  - 3. Current Month's Runtime in XXX.X Hrs
  - 4. Last Month's Runtime in XXX.X Hrs
  - 5. Total Runtime in XXXXXX Hrs
- J. Motor Failures
  - 1. Supervisor level users shall be able to set a common time setpoint that will be used to generate the following alarms.
  - 2. All motors being remotely controlled will generate a fail-to-start when the PLC sends the "start" command to the motor and it does not start after a supervisor adjustable time setpoint. When a fail-to-start is generated, the start output command shall be de-energized and the motor shall be prevented from starting until reset is issued from the GUI.
  - 3. All motors being remotely controlled will generate a fail to stop when the PLC sends the "stop" command to the motor and it continues to run after a supervisor adjustable time setpoint.
  - 4. All motors with adjustable speed control will generate a "speed deviation" alarm when the motor is running and PLC sends a speed setpoint to the motor and it does not reach the correct speed (within a deadband initially set to 10%) within a supervisor adjustable timer setpoint. The motor shall remain running.

K. Analog Alarms

1. Analog alarming capability shall be provided for all analog signals monitored by the PLC as follows.
2. Supervisor level users shall be able to set a common time setpoint that will be used to generate the following alarms after the timer expires. The following alarms (setpoints are supervisor adjustable) will be generated based on the analog feedback value. Each alarm shall include the ability for individual enabling and disabling. High and low analog alarms shall be initially enabled as indicated in the "Alarms/Monitoring" section of each loop.
  - a. High-High
  - b. High
  - c. Low
  - d. Low-Low
  - e. Loss of Signal (Analog signal out of range)
3. A "calibration mode" shall be provided which shall hold the last value prior to calibration mode being activated. When active, calibration mode shall be clearly indicated on any local OITs.

L. Digital Alarms

1. Digital alarms shall be programmed to alarm after a time setpoint expires to eliminate nuisance alarming. Time setpoints to be part of submittal for review by Engineer

END OF SECTION 13491

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. This section describes the general requirements for all mechanical items and systems required by the Contract Documents.
- B. Comply with all Contract Requirements, General Conditions, Supplementary Conditions and Division 1 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.

1.02 RELATED DOCUMENTS

- A. The General Conditions and General Requirements Division 1 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. USAS USA Standards Institute (Formerly ASA)
  - 3. AMCA Air Moving and Conditioning Association
  - 4. ADC Air Diffusion Council
  - 5. NEMA National Electrical Manufacturers Association
  - 6. FM Factory Mutual
  - 7. NFPA National Fire Protection Association
  - 8. ASTM American Society for Testing Materials
  - 9. UL Underwriters Laboratories, Inc.
  - 10. NEC National Electrical Code
  - 11. ASME American Society of Mechanical Engineers
  - 12. ANSI American National Standards Institute
  - 13. OSHA Occupational Safety and Health Act
  - 14. BSA Board of Standards and Appeals
  - 15. MEA Materials and Equipment Acceptance
  - 16. DEC New York State Department of Environmental Conservation - 6 NYCRR Part 613 Handling and Storage of Petroleum
  - 17. ASHRAE American Society of Heating, Refrigeration and AirConditioning Engineers.
  - 18. AWWA American Water Works Association
  - 19. MSS Manufacturer's Standardization Society of the Valve and Fitting Industry
  - 20. ARI American Refrigeration Institute
  - 21. SMACNA Sheet Metal and Air Conditioning Contractor's National Association
  - 22. TEMA Tubular Exchanger Manufacturers Association
  - 23. F.S. or FED Spec. Federal Specification
  - 24. ASA Acoustical Society of America

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25. NACE	National Association of Corrosion Engineers
26. ASSE	American Society of Sanitary Engineers
27. International Building Code	
28. International Fire Code	
29. International Existing Building Code	
30. International Fuel Gas Code	
31. International Plumbing Code	
32. International Energy Conservation Code	
33. International Mechanical Code	
34. New York State Industrial Code Rules	
35. IRI	Industrial Risk Insurers
36. AGA	American Gas Association
37. AABC	American Air Balance Council
38. NEBB	National Environmental Balancing Bureau
39. AWS	American Welding Society

### 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 Architect/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 his proposal for a complete project.
- B. Contractors shall acknowledge that they have examined the Plans, Specifications and Site, and that from his own investigations he has satisfied himself 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 himself with the available information concerning these conditions will not relieve him 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 the Contract Documents, 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 Architect/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

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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 not 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. Breeching layout drawings
  - 3. Piping and equipment layout drawings.
  - 4. Piping materials, valves, hangers, supports and accessories
  - 5. Automatic temperature control equipment, diagrams and control sequences
  - 6. Equipment, fixtures, and appurtenances
  - 7. Insulation
  - 8. 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.
  - 9. Piping freeze protection system.
  - 10. Staging, sequencing of work and maintenance of plant operations.
- 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.

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- 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 Fire Department.

### 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 SAFETY DATA SHEETS

- A. Submit safety data sheets (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



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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. 120V/1/60 Hz, 208V/1/60 Hz or 240V/1/60 Hz: Capacitor start, open drip-proof type, ball bearing, rated 40 C. continuous rise.
  2. 208V/3/60 Hz, 240V/3/60 Hz or 460/3/60 Hz: NEMA B, normal starting torque, single speed, squirrel-cage type, open drip-proof, rated 40 C continuous rise, with ball bearings rated for B-10 life of 100,000 hours and fitted with grease fittings and relief ports. Provide motors with aluminum end brackets with steel inserts in bearing cavities.

### 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 deemed 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 HVAC equipment 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. Refer to Section 01720.

## 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:

## 15010 – GENERAL MECHANICAL REQUIREMENTS

- 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.
- 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 Low Pressure Duct Manual. Provide guards of all that confirm to 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. For Pre-Manufactured Piping Systems, a manufacturers representative shall be onsite to verify that offloading and storage is being performed properly. The representative shall also perform a training with the Contractor on how to properly weld the premanufactured system.
  3. If a minimum number of hours for start-up and instruction are not stated with the equipment specifications, these shall be 2 full 8-hour working days as a minimum.
  4. Advise Owner of start-up at least 72 hours in advance.
- H. Do not install pipe or conduit through ductwork.
- I. 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.
- J. 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.

### 3.07 CLOSEOUT PROCEDURES

- A. 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.
- B. Where applicable, provide instruction and training, including application of special coatings systems, at manufacturer's recommendation.
- C. 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
- D. Warranties, bonds, maintenance agreements, and similar continuing commitments.
- E. 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.
- F. Prepare instruction periods to consist of approximately 50% classroom instruction and 50% "hands-on" instruction. Provide minimum instruction periods as follows:

<b>Systems or Equipment</b>	<b>Training Time (Hours)</b>
All other equipment	4 (each)

Note: Consult individual equipment specification sections for additional training requirements.

- G. Prepare a written agenda for each session and submit for review and approval. Include date, location, purpose, specific scope, proposed attendance and session duration.
- H. 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 15010

## 15015 – MECHANICAL DEMOLITION

### PART 1 - GENERAL

#### 1.01 DESCRIPTION OF WORK

- A. This Section describes the draining, disconnecting, dismantling, demolition, removal, relocation, rerouting and reconnection of existing mechanical facilities, in a neat and workmanlike manner, of mechanical systems, materials and accessories as required, as shown on the Drawings and specified herein, to accomplish alteration, restoration and to accommodate the Work.

#### 1.02 RELATED WORK

- A. General Mechanical Requirements - Section 15010

#### 1.03 REFERENCES

- A. NFPA Fire Code
- B. ANSI A10.6 - Safety Requirements for Demolition
- C. National Association of Demolition Contractors (NADC) - Demolition Safety Manual
- D. NFPA 51B - Cutting and Welding Processes
- E. NFPA 70 - National Electrical Code
- F. NFPA 241 - Safeguarding Building Construction and Demolition Operations
- G. OSHA 29 CFR 1910 - Occupational Safety and Health Standards
- H. US EPA - Clean Air Act Amendment of 1990.

#### 1.04 SUBMITTALS

- A. Demolition Schedule
- B. Fire Watch Procedures
- C. Inspection Report of Underground Piping Systems
- D. Welding/Burning Permit - Obtain a welding/burning permit from the local Fire Official prior to the start of any welding or burning in accordance with the local Fire Code or as required by the Owner.

#### 1.05 QUALITY ASSURANCE

- A. Only employ workers skilled in the specific trades involved for cutting, patching and removal.
- B. Job Conditions: Prior to start of the Work, make an inspection accompanied by the Architect/Engineer to determine physical condition of adjacent construction that is to remain.

#### 1.06 SPECIAL PRECAUTIONS

- A. Do not torch cut ductwork.

## 15015 – MECHANICAL DEMOLITION

- B. Torch cutting of other mechanical equipment will be permitted only with the specific written approval of the Architect/Engineer.
- C. Include “Fire Watch” procedures as required by the Fire Code and/or Owner’s Fire Insurance Carrier for any cutting work that may produce sparks, see 01356 for Hot Work Permit. Submit fire watch procedures for approval.
- D. Perform draining operations so that damage to existing building components does not occur.

### PART 2 - PRODUCTS

#### 2.01 GENERAL

- A. Adequately sized rubbish containers for the proper and safe disposal of all debris.

### PART 3 - EXECUTION

#### 3.01 PREPARATION

- A. Construct temporary partitions enclosing respective work prior to any demolition work. Erect temporary fencing and signage around demolished materials.
- B. Protect existing materials and equipment which are not to be demolished.
- C. Prevent movement of structure; provide required bracing and shoring.
- D. Do not begin the work until the time schedules and manner of operations have been approved by the Architect/Engineer and Owner. Include all interruptions of existing services in schedules submitted for approval by the Architect/Engineer and Owner.

#### 3.02 GENERAL

- A. Provide alteration and demolition of mechanical facilities as required by the Drawings and Specifications. The Drawings are diagrammatic and do not show the exact location of all existing mechanical work. Where existing equipment is to remain in service during construction, provide rerouting and reconnection of mechanical services as required to maintain continuous service.
- B. Review all equipment with the Architect/Engineer and Owner prior to disposal. Completely remove existing ductwork, piping, conduit and similar items to be abandoned that are not embedded in walls or floor slabs unless otherwise shown on the Drawings. Cap open ends at all walls and floors.
- C. Remove, store and protect all equipment or materials designated to be turned over to the Owner. Coordinate exact location of storage with the Owner.
- D. Temporarily cap ends of ductwork, piping and sanitary vent piping to avoid entry of dirt, debris, or discharge of foul odors and gases.
- E. Where existing louvers or ductwork penetrations are to remain, blank-off the opening on the inside with galvanized sheet metal on both sides of 2-inch thick, 6 pcf density rigid fiberglass board insulation. Paint side attached to the opening with weather resistant flat black paint.
- F. Do not close or obstruct egress width to exits.

- G. Do not disable or disrupt building fire or life safety systems without five (5) days prior written notice to the Architect/Engineer and Owner.
- H. Conform to procedures applicable when discovering hazardous or contaminated materials.
- I. Conduct demolition to minimize interference with adjacent building structures or Owner's operations.
- J. Cease operations immediately if structure appears to be in danger or hazardous materials are encountered. Notify Architect/Engineer. Do not resume operations until directed.
- K. Demolish in an orderly and careful manner. Do not cut or remove more than is necessary to accommodate the new construction or alteration.
- L. Remove demolished materials from site daily. Do not burn or bury materials on site. Dispose of all material at an approved disposal facility.
- M. Protect finished surfaces at all times and repair or replace, if damaged, to match existing construction to the satisfaction of the Architect/Engineer.

### 3.03 PIPING REMOVAL

- A. Cut off all welded piping square at the locations indicated on the Drawings. No cutting is required where the demolition ends at a flanged valve or equipment. Close off all openings of any remaining valves, piping or fittings with weld caps or blind flanges to prevent debris from entering the existing system.
- B. Disconnect all threaded piping at the location indicated on the Drawings. Close off all openings of remaining valves, piping, fittings and equipment with pipe plugs or pipe caps as required to prevent debris from entering the existing systems.
- C. Remove all pipe hangers, supports, miscellaneous steel and anchors with the piping.

### 3.04 PROTECTION FROM FREEZING

- A. It is intended that the building remain protected from damage due to freezing temperatures. To that end, keep in place and in operation existing equipment and systems used for heating until scheduling permits shutdown.
- B. Where the removal of equipment, etc. will leave an area unprotected from freezing, notify the Owner and Architect/Engineer at least 72 hours in advance prior to removal so appropriate steps can be taken by the Owner to protect the area. Provide temporary heating equipment sufficient to prevent freezing.
- C. It is the Contractor's responsibility to ensure that piping systems that are being worked on are completely drained from water prior to the start of demolition. If water is not drained and the water freezes it is the Contractor's responsibility to replace piping and repair all damages caused by water leakage at his own expense.

### 3.05 DISCONNECTION AND INTERRUPTION OF MECHANICAL SERVICES

- A. When portions of an existing piping system or ductwork system are removed, and this removal causes loss of operation to another piece of equipment due to open or disconnected piping or ductwork, cap piping or ductwork or provide temporary piping or ductwork system to retain operation of the system.



## 15015 – MECHANICAL DEMOLITION

### 3.06 MECHANICAL EQUIPMENT REMOVAL

- A. Remove all mechanical equipment as shown on the Drawings. Remove all electrical work, including wiring between equipment, and wiring to power source or point of origin.
- B. Where equipment is supported by steel and/or structural supports, remove these supports.

### 3.07 DUCTWORK REMOVAL

- A. Disconnect all ductwork which must be removed, at the closest joint and support the remaining ductwork.
- B. Prepare all remaining ductwork joints at the point of disconnection to receive new ducts or blank-off panels.
- C. Remove all ductwork supports and miscellaneous steel with ductwork to be demolished.

### 3.08 INSULATION REMOVAL

- A. Remove insulation, together with all piping, fittings, valves and equipment designated for demolition.

END OF SECTION 15015

## PART 1 - GENERAL

### 1.01 - SECTION INCLUDES

- A. Support of exposed piping. Pipe hangers shall be meant to include pipe support systems.
- B. The Drawings show the layout, sizes, elevations, and general arrangement of piping, valves, primary instrumentation elements, and process equipment. Pipe support systems shall be selected, configured, and installed in order to comply with the requirements contained herein. Install pipe support systems consisting of hangers, supports, clamps, U-bolts, brackets, bracings, attachments, and structural shapes to adequately support piping from building components, tank walls, decking, walkways, slabs, or fabricated structural assemblies specifically designed for this purpose.

### 1.02 - REFERENCES

- A. Comply with the following in designing and installing pipe support systems:
  - 1. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
  - 2. MSS SP69 - Pipe Hangers and Supports - Selection and Application
  - 3. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practice
- B. Terminology used in this Section is defined in MSS SP-90.

### 1.03 - SUBMITTALS

- A. Comply with the requirements in Section 01300.
- B. Submit the following:
  - 1. Product data and installation instructions.
  - 2. Pipe hanger and support catalog cuts showing manufacturer's figure number, size, materials of construction, and features for each type of support.
  - 3. Provide catalog cuts for all types of 316 stainless steel pipe supports.
  - 4. Provide details of each size knee brace and indicate materials of construction and the proposed locations.

### 1.04 – QUALITY ASSURANCE

- A. Where product specifications are provided they are intended to provide a standard of quality.
- B. All interior and exterior pipe support systems shall be type 316 stainless steel.
- C. Below grade pipe support systems shall be as specified for underground pipe.

## 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.
2. Swivel ring type hangers will be allowed for sprinkler piping up to a maximum of 2 inches in size.
- E. Adjustable Floor Rests and Base Flanges: Stainless 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 - SEISMIC RESTRAINT SYSTEM FOR PIPING

- A. General:
  - 1. Coordinate all structural attachments with the Engineer.
  - 2. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
  - 3. Analysis shall detail anchoring methods, bolt diameter and embedment depth.
  - 4. Design seismic restraint devices to accept without failure the forces calculated per the applicable building code.

5. Friction from gravity loads shall not be considered resistance to seismic forces.
  7. Construct seismic supports so that support engagement is maintained.
  8. Stamp seismic supports with manufacturer's name and part number for identification.
  9. Design seismic supports specifically for mitigation of seismic force loads.
  10. Design the stiffness of seismic restraints for mechanical equipment so that the load path for the restraint performs its intended function.
  11. Where possible, utilize components designed with tamper resistant break-off bolt heads or break-off nuts to assure visual verification of proper installation.
  12. Attachment components shall be UL Listed catalog components with published loads designed specifically for seismic application.
- B. Type: Pre-engineered seismic restraint system designed to support and restrain piping to meet applicable lateral force requirements.
- C. Manufacturers:
1. B-Line.
  2. Mason Industries.
  3. TOLCO Inc.
- D. Strut/Channel Bracing: 12 gauge solid stainless steel with no holes, 1-5/8 inches wide x 1-5/8 inches deep of single lengths or stitch-welded back-to-back configurations.
- E. Pipe Bracing: Schedule 40 stainless steel pipe.
- F. Cable Bracing: Pre-stretched galvanized aircraft cable 7 x 19 strand core.
- G. Rigid Seismic Braces for Single Hung Pipe Systems: A12 strut channel or schedule 40 steel pipe. Maximum Brace Length: 13 feet-1 inches.
- H. Rigid Seismic Braces for Trapeze Supported Pipe Systems: A12 strut channel or schedule 40 steel pipe. Maximum Brace Length: 13 feet-1 inches.
- I. Cable Seismic Braces for Single Hung Pipe Systems: Pre-stretched aircraft cable 7 x 19 core.
- J. Cable Seismic Braces for Trapeze Supported Pipe Systems: Pre-stretched aircraft cable 7 x 19 core.
- K. Structural Attachments for Rigid and Cable Seismic Braces for Single Hung and Trapeze Supported Pipe Systems:
1. Structural attachments shall be positive.
  2. Do not make structural attachments to the bottom of a bar joist.

3. Supplemental steel shall be installed for all pre-cast decks less than 4 inches thick
4. Do not use concrete inserts or continuous concrete insert strut to attach brace.
5. Wedge type anchors are permitted. The size and embedment depth shall be determined by the supplier of the seismic restraint system and as approved.

L. Vertical Brace Component (up-thrust protection)

1. Reinforce Vertical Hanger Rod when lengths exceed the following:
  - a. 3/8 inch dia rod: 19 inches.
  - b. 1/2 inch dia rod: 25 inches.
  - c. 5/8 inch dia rod: 31 inches.
  - d. 7/8 inch dia rod: 43 inches.
  - e. 1 inch dia rod: 50 inches.
  - f. 1-1/4 inch dia rod: 62 inches.

2.04 - FASTENERS

- A. Bolts, Nuts, Washers, Lags, and Screws: Stainless steel; size and type to suit application; galvanized for treated wood. Except where shown otherwise on the Drawings, furnish type, size and grade required for proper installation of the Work.

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. Do not bend threaded rod.
- B. Support all insulated horizontal piping conveying fluids below ambient temperature, by means of hangers or supports with insulation shields installed outside of the insulation.
- C. 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

## 2. 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

No pipe length shall be left unsupported between any two coupling joints.

## 3. For Copper Pipe and Copper Tubing:

PIPE OR TUBING SIZE (Inches)	MAXIMUM SPACING (Feet)
1-1/2 and under	6
2 and over	10

## 4. For Plastic Tubing:

PIPE OR TUBING SIZE (Inches)	MAXIMUM SPACING (Feet)
Under 2 inch	3
2 inch and over	4

## 5. 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) 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.

6. 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.

7. 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.

8. 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.
9. 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.
10. 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. Install intermediate supports between riser clamps on maximum 6 foot centers, for copper tubing risers 1-1/4 inches in size and smaller, installed in finished rooms or spaces other than mechanical equipment machine or steam service rooms, or penthouse mechanical equipment rooms.



## 15060 - PIPE HANGERS

4. 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.
  5. 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. Underground Cast Iron 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 Cast-In-Place Concrete: Secure to overhead construction by means of cast-in-place concrete inserts.

#### D. 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.

3.04 - ANCHORS, RESTRAINTS, RIGID SUPPORTS, STAYS AND SWAY BRACES

- A. Install pipe anchors, restraints and sway braces, at locations as determined by Contractor under performance requirements of this Section. Design anchors so as to permit piping to expand and contract freely in opposite directions, away from anchor points. Install anchors independent of all hangers and supports, and in a manner that will not affect the structural integrity of the building.
- B. 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 - 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.

3.06 - 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.

3.07 - 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.

3.08 - SEISMIC RESTRAINT SYSTEMS

- A. General:
  - 1. Install seismic restraints in accordance with seismic restraint manufacturer's printed installation instructions and guidelines unless otherwise specified.
  - 2. Do not use powder-actuated fasteners for seismic restraint anchorage in tension applications.
  - 3. Laterally support vertical risers with riser clamps at each floor unless otherwise specified.
  - 4. When systems cross building seismic separation points, pass between buildings, or are

supported from different portions of the building, install to allow differential support displacements without damaging the pipe, equipment or support connections. Install pipe loops, anchors, offsets, and guides as required to provide specified capability of motion and limit movement of adjacent piping.

5. Do not brace seismic bracing to different parts of the building that may respond differently during seismic activity.
6. Provide adequately sized openings in walls, floors and ceilings for anticipated seismic movement. Provide fire stopping in fire-rated walls.
7. Seismic restraint installations shall not cause any modifications in the positioning of equipment or piping resulting in stresses or misalignment.
8. No rigid connections between equipment, piping, duct, or conduit shall be made to the building structure that degrades the noise and vibration-isolation system specified.
9. Bracing attached to structural members may present additional stresses. Submit calculations stamped by a NYS Licensed Professional Engineer.
10. Provide vertical stiffening components to support rods when necessary to accept compressive loads. Welding of components to vertical support rods is not acceptable.
11. Clevis supported pipe must have cross-bolt support at each seismic bracing location.
12. Notify Engineer of discrepancies between the specifications and field conditions prior to installation.

B. Seismic Restraints for Piping:

1. Trapeze assemblies supporting pipes shall be braced considering the total weight of the pipes on the trapeze.
2. Provide transverse bracing at 40 feet maximum spacing for welded steel pipe, brazed copper pipe or grooved piping with UL 213 listed connections.
  - a. Traverse bracing for threaded steel or copper pipe or non-listed UL grooved connections shall not exceed 20 feet maximum.
3. Provide longitudinal bracing at 80 feet maximum spacing for welded steel pipe, brazed copper pipe or grooved piping with UL 213 listed connections.
  - a. Traverse bracing for threaded steel or copper pipe or non-listed UL grooved connections shall not exceed 40 feet maximum.
4. Transverse piping restraints for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24-inches of the elbow centerline or tee or combined stresses are within allowable limits at longer distances.
5. Branch line piping shall not be used to brace main piping.
  - a. No larger diameter pipe shall be braced by a smaller diameter pipe.

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6. Attach all longitudinal seismic braces directly to piping.
  - a. Encapsulate clamp and brace with insulation equal to that on the pipe.
7. Use hold down clamps to attach pipe to trapeze hangers before installing seismic restraints.
8. Brace vibration isolated piping with cables to allow flexibility.

END OF SECTION 15060

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## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

- A. This Section describes the marking and identification materials for identifying mechanical equipment, ductwork and piping systems.
- B. Mark and identify all mechanical 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 MANUFACTURERS

- A. Seton
- B. Bunting
- C. W.H. Brady Company
- D. Or approved equal.

### 2.02 VALVE TAGS

- A. Provide valve tags for all valves installed for this project. Valve tags shall be constructed of 316 stainless steel, with stamped letters and service designation tag size minimum 1-1/2 inches (38 mm) diameter with smooth edges, 316 stainless steel 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 Architect/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 316 stainless steel 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.

## 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.

## 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 can be 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 SCHEDULES

- A. Pipe Marker Letter Size Schedule:

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Outside diameter of insulation or pipe (Inches)	Letter height (Inches)	Color field (Inches)
3/4-1 to 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 15075



+ + NO TEXT ON THIS PAGE + +

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install complete and ready for operation and test all non-buried valves as shown on the Drawings and as specified herein.
- B. The equipment shall include, but not be limited to, the following; however not all items specified herein may be included in this project.
  - 1. General Requirements
  - 2. Butterfly Valves
  - 3. Gate Valves
  - 4. Flap Valves
  - 5. Resilient Seated Knife Gate Valves
  - 6. Eccentric Plug Valves (Four Inches and Larger)
  - 7. Eccentric Plug Valves (Smaller than Four Inches)
  - 8. Check Valves
  - 9. Sewage Air Release Valves
  - 10. Stainless Steel Ball Valves
  - 11. Floor Stands
  - 12. Valve Actuators (Hydraulic Cylinder Operator)

1.02 RELATED WORK

- A. Instrumentation, not specified herein, is included in Division 13.
- B. Electrical work is included in Division 16.
- C. Electric valve operators of all types, rate of flow controllers (including modulating valves and operators) if not included herein are included in Division 13.

1.03 SUBMITTALS

- A. Submit to Engineer, in accordance with Section 01300, materials required to establish compliance with this Section. First submittal shall be valve schedule described in Paragraph 1.09. Approval of valve schedule submittal is required prior to Contractor submitting any of equipment in this specification. Subsequent Equipment Submittals shall include at least the following:
  - 1. Valve tag number.
  - 2. Manufacturer and supplier.

3. Address at which equipment will be fabricated or assembled.
4. Drawings showing assembly details, materials of construction and dimensions.
5. Descriptive literature, bulletins and/or catalogs of the equipment.
6. Total weight of each item
7. A complete bill of materials.
8. Additional submittal data, where noted with individual pieces of equipment.
9. Individual electrical control schematics and wiring diagrams for each valve operator with external interfaces, identified exactly as detailed on Electrical and Instrumentation Drawings. Standard catalogue cut sheets that show typical wiring diagrams only are not acceptable. Valve actuators shall be coordinated with electrical requirements shown on Drawings and valves as specified herein.

B. Test Reports:

1. Provide certified hydrostatic test data, per manufacturer's standard procedure or MSS-SP- 61 for valves.

C. Certificates:

1. For each valve specified to be manufactured, tested and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with appropriate standards, including certified results of required tests and certification of proper installation.

D. Manufacturer's Installation and Application Data.

E. Operating and Maintenance Data.

1. Operating and maintenance instructions shall be furnished to Engineer as provided in Section 01730. Instructions shall be prepared specifically for this installation and shall include required cuts, drawings, equipment lists, descriptions and other information required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.04 REFERENCE

A. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
3. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
4. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
5. ASTM A436 - Standard Specification for Austenitic Gray Iron Castings.

6. ASTM A536 - Standard Specification for Ductile Iron Castings.
7. ASTM B30 - Standard Specification for Copper-Base Alloys in Ingot Form.
8. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

B. American Water Works Association (AWWA):

1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C500 - Metal-Seated Gate Valves Supply Service.
3. AWWA C504 - Rubber-Seated Butterfly Valves.
4. AWWA C507 - Ball Valves, 6-in through 48-in (150mm through 1200mm).
5. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-in (50mm through 24-in (600mm) NPS.
6. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
7. AWWA C511 - Reduced-Pressure Principle Backflow-Prevention Assembly.
8. AWWA C540 - Power-Actuating Devices for Valves and Sluice Gates.
9. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane Type Actuators for Valves and Slide Gates.
10. AWWA C550 - Protective Epoxy Interior Coatings for Valves and Hydrants.
11. AWWA C800 - Underground Service Line Valves and Fittings.

C. American National Standards Institute (ANSI):

1. ANSI B1.20.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).
2. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
3. ANSI B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
4. ANSI B16.104 - Butterfly Valves.

D. American Iron and Steel Institute (AISI).

E. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS):

1. MSS-SP-61 - Pressure Testing of Steel Valves.
2. MSS-SP-67 - Butterfly Valves.
3. MSS-SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
4. MSS-SP-71 - Cast Iron Swing Check Valves, Flanges and Threaded Ends.

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5. MSS-SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Services.
6. MSS-SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
7. MSS-SP-80 - Bronze Gate, Globe, Angle and Check Valves.
8. MSS-SP-82 - Valve Pressure Testing Methods.
9. MSS-SP-98 - Protective Coatings for the Interior of Valves, Hydrants and Fittings.

F. National Electrical Manufacturers Association (NEMA).

G. Underwriters Laboratories (UL).

H. Factory Mutual (FM).

I. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

### 1.05 QUALITY ASSURANCE

A. Qualifications:

1. Valves and appurtenances shall be products of well-established firms who are fully experienced, minimum ten years, reputable and qualified in manufacture of particular equipment to be furnished.
2. Equipment shall be designed, constructed and installed in accordance with best practices and methods and shall comply with this Section as applicable.
3. Units of the same type shall be the product of one manufacturer.

B. Certifications:

1. Manufacturers shall furnish an affidavit of compliance with Standards referred to herein as specified in Paragraph 1.03C above. Refer to Part 3 for testing required for certain items in addition to that required by referenced standards.

C. Inspection of units may also be made by Engineer or other representative of Owner after delivery. Equipment shall be subject to rejection at any time due to failure to meet any of specified requirements, even though submittal data may have been accepted previously. Equipment rejected after delivery shall be marked for identification and shall be removed from job site at once.

### 1.06 SYSTEM DESCRIPTION

- A. Equipment and materials specified herein are intended to be standard for use in controlling flow of wastewater, and air as noted on Drawings.
- B. Valves, appurtenances and miscellaneous items shall be installed as shown on Drawings and as specified, so as to form complete workable systems.

### 1.07 DELIVERY, STORAGE AND HANDLING

## 15100 – VALVES

- A. Reference is made to Section 01610 for additional information.
- B. Packing and Shipping:
  - 1. Care shall be taken in loading, transporting and unloading to prevent injury to the valves, appurtenances, or coatings. Products shall not be dropped. Valves and appurtenances shall be examined before installation and no piece shall be installed which is found to be defective. Damage to the coatings shall be repaired as acceptable to Engineer.
  - 2. Prior to shipping, ends of valves shall be acceptably covered to prevent entry of foreign material. Covers shall remain in place until after installation and connecting piping is completed.
    - a. 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.
    - b. Valves smaller than 3-in shall be shipped and stored as above except that heavy cardboard covers may be used on the openings.
    - c. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until the valve is installed and put into use.
    - d. Corrosion in evidence at the time of acceptance by the Owner shall be removed, or the valve shall be removed and replaced.
- C. Storage and Protection:
  - 1. Special care shall be taken to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, to prevent deformation. See the individual piping sections and manufacturer's information for further requirements.

### 1.08 MAINTENANCE

- A. Special tools and the manufacturer's standard spare parts, if required for normal operation and maintenance, shall be supplied with the equipment in accordance with Section 01730 and where noted, as specified herein. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended.
- B. Provide one operations and maintenance manual for each type of valve and operator supplied under this specification in accordance with Section 01730.
- C. Included within operations and maintenance manuals, provide a list of all spare and replacement parts with individual prices and location where they are available.

### 1.09 VALVE DESIGNATIONS AND SCHEDULE

- A. Valves shall be identified by a unique valve tag as identified in valve schedule prepared by Contractor. Specific type of valve to be used will be identified by symbol and/or call out on Drawings. Contractor shall identify each valve by its assigned tag number on shop drawings and equipment submittals.
- B. Contractor shall refer to the P&IDs and mechanical plans for type of each valve called out by abbreviation or drawing symbol. Prior to first valve submittal, Contractor shall submit a detailed valve schedule listing process valves to be furnished along with Contract Drawing P&IDs edited electronically which shall include valve tag numbers identifying each valve. Valve schedule shall include: valve tag number; valve designation; valve size; end connections and operator type.

## PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT - GENERAL

- A. Reference is made to Division 1 for additional requirements, including nameplates, provisions for temporary pressure gauges, protection against electrolysis and anchor bolts.
- B. Use of a manufacturer's name and/or model or catalog number is for purpose of establishing standard of quality and general configuration desired.
- C. Valves and appurtenances shall be of size shown on the Drawings or as noted and as far as possible equipment of same type shall be identical and from one manufacturer.
- D. Valves and appurtenances shall have name of manufacturer, nominal size, flow directional arrows, working pressure for which they are designed and standard referenced, cast in raised letters or via riveted stainless steel nameplate upon an appropriate part of the body.
- E. Unless otherwise noted, items shall have a minimum working pressure of 150 psi or be of same working pressure as pipe they connect to, whichever is higher and suitable for pressures noted where they are installed.
- F. Joints, size and material - unless otherwise noted or required by Engineer:
  - 1. Except where noted, joints referred to herein shall be of same type, nominal diameter, material and with a minimum rating equal to pipe or fittings they are connected to.
  - 2. Valves and appurtenances shall be of same nominal diameter as pipe or fittings they are connected to.
  - 3. Valves exposed to view, or in vaults:
    - a. Plastic valves in chemical service - solvent cement, or flanged ends.
    - b. 3-in and smaller - threaded ends- unless noted otherwise herein or on Drawings.
    - c. 4-in and larger - flanged ends.
- G. Provide special adaptors as required to ensure compatibility between valves, appurtenances, and adjacent pipe.
- H. No alternative materials will be considered for approval unless complete documentation is provided regarding their satisfactory long-term use in similar conditions; in addition, the consideration of any substitution will be considered only if superiority of proposed materials is the intent of substitution, and only if sufficient evidence is provided to document that superiority.

2.02 BUTTERFLY VALVES

- A. Energy Efficient Process Duty Butterfly Valves: Tag Type BFV4.
  - 1. Valves shall be high flow, concentric disc, bi-directional seal, hard backed cartridge seat, wafer style, except for dead end service, where fully lugged valves shall be used. Valves shall be 50 PSI pressure rated for low pressure air service, 150 PSI rated for fluid service. Air service valves shall be fitted with trim capable of continuous 250 degree F. service, intermittent 300 degree F. service.
  - 2. Body shall be one piece cast iron for wafer style, ductile iron for lug style. Body class shall be ASME 150.

3. Disc shall be undercut type if employed for air service, material shall be ASTM B 148 C954 or C955 aluminum bronze or CF8M stainless steel. Valve discs shall employ a positive machined drive utilizing a rectangular drive connection, or shall be attached using Type 416 stainless steel taper pins or bolts with locking nuts.
4. Valves shall have dry stem journals with no leakage to stems at rated pressure. Stem packing shall not be required. Valves shall be constructed with separate upper and lower stems or single through stems. Separate stems shall be positively retained by tangential pins. Stems shall be 17-4 PH or Type 416 stainless steel. Through stem design shall be supported by a minimum of two upper bearings and one lower bearing.
5. Seats shall be hard backed cartridge type consisting of a resilient EPDM liner molded to a rigid non-metallic backing ring. Viton liners shall be utilized for high temperature or corrosive duty service. Valve seats shall be field replaceable with hand tools.
6. Upper stem shall be guided by two self-lubricating bronze or PTFE bearings, lower stem for single piece stem designs shall be guided by one self-lubricating bronze or PTFE bearing.
7. Manual operation shall be provided. Hand wheel shall be automatically disengaged from the drive during electrical operation of the actuator. Hand wheel shall be engaged by means of a hand/auto selection lever. Actuator shall be able to be locked in either manual or automatic position via lockable padlock hasp, padlock provided by others. Emergency disengagement of the motor drive shall be accomplished by depressing and holding the hand/auto lever during electric operation of the valve.
8. Valves installed six (6) feet above finished floor or higher shall be provided with chainwheel operators and stainless steel chain.
9. Valves shall be
  - a. Crane Centerline Series 200
  - b. Apollo Series 141
  - c. Demco NE-C (2" to 12") or NF-C (14" to 24"), manufactured by Cameron Valves & Measurement
  - d. or equal.

## 2.03 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:



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- 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 or in coordination with floor stand.
  - 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.

### 2.04 FLAP VALVES

- A. Flap valve shall have a cast iron body and cover.
- B. The seat and disc ring shall be bronze, and the hinge pin and cotter pins shall be stainless steel.
- C. The valve shall be constructed with a 10-degree offset from vertical to ensure positive close.
- D. The flange shall be drilled using an ANDI 125# template.
- E. All iron parts shall be coated in TNEMEC 2-part epoxy with 3-4 mils dry film thickness to prevent rusting or corrosion.
- F. The valve shall be machined, assembled, and tested in the USA for quality assurance.
- G. The manufacturer shall submit proof of ISO 9001 certification.
- H. Valve and accessories shall be manufactured by Troy Valve Model A2540 or approved equal.

### 2.05 Resilient Seated Knife Gate Valves

- A. Manufacturers: Provide products of one of the following:

1. DeZurik
2. Flexgate EFG as manufacturer by the Red Valve CO., Inc. of Carnegie, PA
3. Or Approved Equal

B. General

1. Provide valves conforming to AWWA C520 and as specified in this Section.
2. Size: 12-inch and 18-inch diameters.
3. Minimum Rated Differential Working Pressure: 10 psig.
4. Valve shall be suitable for vertical 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.
5. Provide flat bottom gate with full perimeter seating against the seat. Seat shall be fully replaceable from the top of the valve.
6. Packing and packing gland shall be externally adjustable and accessible without disassembling valve or removing the actuator.
7. Stem nut shall be replaceable from the top of the yoke without removing the yoke.
8. Valve body shall be lug style, solid cast in one piece. End connections shall conform to ANSI B16.5.
9. Provide each valve with a handwheel actuator. All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings. Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lbs (178N) on the crank or handwheel, and shall be able to withstand, without damage, an effort of 80 lbs (356N). The crank shall be removable and fitted with a corrosion-resistant rotating handle. The maximum crank radius shall be 15 inches and the maximum handwheel diameter shall be 24 inches.
10. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents and a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

C. Materials of Construction

1. Valve Body: Fabricated Steel
2. Gate, Gland, Seat Ring, Retainer Seat and Retaining Ring: Type 316 Stainless Steel.
3. Seat and O-ring: Acrylonitrile-butadiene (NBR)
4. Stem and Yoke: Type 304 Stainless Steel.
5. Packing: Teflon.
6. Internal and external bolting and other hardware, including pins, set screws, studs, bolts, nuts, and washers, shall be Type 316 stainless steel.

D. Testing: Test valves in manufacturer's shop in accordance with AWWA C520.

2.06 ECCENTRIC PLUG VALVES (Four inches and larger)

A. Manufacturer: 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. Materials of Construction for plug valves used for grit applications:
  1. Comply with materials of construction specified in Article 2.4.C herein with the following exceptions.
  2. Body shall be lined with tmemec series 141
  3. Plug:
    - a. For all grit plug valves plugs shall be fully encapsulated with rubber.
  4. Stem Seal: Multiple neoprene or Buna V-ring type.
- E. 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.
- F. 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.

2.07 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.

## 2.08 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.

## 2.09 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:
  - 1. Compact Tubular Single-Chamber Body and Cover: stainless steel.
  - 2. Hollow Direct Acting Float: stainless steel.
  - 3. Solid Cylindrical Large Orifice Control Float: stainless steel.
  - 4. Nozzle: stainless steel
  - 5. Woven Dirt-Inhibitor Screen: stainless steel.
  - 6. Seat: Buna-N.
  - 7. Seals: nitrile rubber.
  - 8. Lever Arms: Bronze or stainless steel.

## 2.10 STAINLESS STEEL BALL VALVES

- A. Manufacturers: Provide products of one of the following:
  - 1. Victaulic Company.
  - 2. Milwaukee 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.

#### 2.11 FLOOR STANDS

- A. Manufacturer: Floor stands and accessories shall be furnished by the valve manufacturer.
- B. Floor stands shall be heavy pattern type, with non-rising stem, handwheel, and valve position indicator. Ball thrust bearings shall be used. Floor stands shall be factory primed and factory painted using the paint system specified in Section 09910 for exterior ferrous metals or an equivalent paint system may be used if approved by the Engineer.

#### 2.12 VALVE ACTUATORS (HYDRAULIC CYLINDER OPERATOR)

- A. Actuators shall confirm to AWWA Standard C540, insofar as applicable and as herein specified. Actuators shall be O-ring sealed, watertight to standard NEMA 4X/6, submersion to 6 feet for 30 minutes.
- B. Valve service/operation shall be as indicated on the P&IDs.
- C. Modulating actuators shall contain proportional control unit and be capable of 1200 starts per hour, open-closed valve actuators shall not require a proportional control unit, and be capable of 60 starts per hour.
- D. Actuators shall have a digital control module, to allow valves or gates to be positioned remotely via a 2-wire 4-20mA signal. The actuators shall have the following inputs and outputs for interfacing with the plant SCADA system:
  1. 4-20mA input for position control
  2. 4-20mA output for position feedback
  3. Dry contact output for monitoring that actuator is in Remote Control mode
  4. Dry contact output for monitoring that the valve is fully opened
  5. Dry contact output for monitoring that the valve is fully closed
- E. Each actuator shall be provided with supply air regulator, supply air filter and pressure gages. The pressure gages shall be provided with a range of 0-160psi. The regulators with 3/8 NPT connections, max inlet pressure 250 psi and max output pressure of 100 psi. The inline coalescing filters with a grade DX filter that is 93% efficient at 0.1 micron and designed for a max inlet pressure of 250 psi.
- F. Cylinders: Hydraulic Cylinder Operators for rubber seated flow control valves shall move valve to any position from full open to full closed where a minimum pressure of 50 PSI is applied to the cylinder. Wetted parts of cylinder shall be corrosion resistant and cylinder rods shall be corrosion resistant stainless steel. Rod seals shall be of non-adjustable wear compensating type. Cylinder actuators shall be Pratt MDT Type with a Dura-Cyl Cylinder. Four limit switches shall be provided on cylinder operator.

#### 2.13 SURFACE PREPARATION AND SHOP COATINGS

- A. Notwithstanding any of these specified requirements, coatings and lubricants in contact with potable water shall be certified as acceptable for use with that fluid.

- B. If manufacturer's requirement is not to require finished coating on interior surfaces, then manufacturer shall so state and no interior finish coating will be required, if acceptable to Engineer.
- C. Exterior surface of various parts of valves, operators, floor-stands and miscellaneous piping shall be thoroughly cleaned of all scale, dirt, grease or other foreign matter and thereafter one shop coat of an approved rust-inhibitive primer such as Inertol Primer No. 621 shall be applied in accordance with instructions of paint manufacturer or other primer compatible with finish coat provided.
- D. Unless otherwise noted, interior ferrous surfaces of valves shall be given a shop finish of an asphalt varnish conforming to AWWA C509, (except mounting faces/surfaces) or epoxy conforming to AWWA C550 with a minimum thickness of 6 mils.
- E. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating. Mounting surfaces shall be especially coated with a rust preventative.
- F. Take care to protect uncoated items and plastic items, especially from environmental damage.

#### 2.14 FACTORY INSPECTION AND TESTING

- A. Factory inspection, testing and correction of deficiencies shall be done in accordance with the referenced standards and as noted herein.
- B. In addition to tests required by referenced standards, the following shall also be factory tested:
  - 1. Butterfly valves, gate valves, plug valves, check valves shall be factory tested to demonstrate drop tight closure at specified conditions.

### PART 3 EXECUTION

#### 3.01 INSTALLATION - GENERAL

- A. Valves and appurtenances shall be installed per manufacturer's instructions in locations shown, true to alignment and rigidly supported. Damage to above items shall be repaired to satisfaction of Engineer before they are installed.
- B. Install brackets, extension rods, guides, various types of operators and appurtenances as shown on Drawings, or otherwise required. Before setting these items, check Drawings and figures which have a direct bearing on their location. Contractor shall be responsible for proper location of valves and appurtenances during construction of the work.
- C. Materials shall be carefully inspected for defects in construction and materials. Debris and foreign material shall be cleaned out of openings, etc. Valve flange covers shall remain in place until connected piping is in place. Operating mechanisms shall be operated to check their proper functioning and nuts and bolts checked for tightness. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced at no additional cost to Owner.
- D. Where installation is covered by a referenced standard, installation shall be in accordance with that standard, except as herein modified, and Contractor shall certify such. Also note additional requirements in other parts of this Section.
- E. Unless otherwise noted, joints for valves and appurtenances shall be made up utilizing same



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procedures as specified under applicable type connecting pipe joint and valves and other items shall be installed in proper position as recommended by manufacturer. Contractor shall be responsible for verifying manufacturers' torqueing requirements for all valves.

### 3.02 INSTALLATION OF MANUAL OPERATIONAL DEVICES

- A. Unless otherwise noted, operational devices shall be installed with units of factory, as shown on Drawings or as acceptable to Engineer to allow accessibility to operate and maintain item and to prevent interference with other piping, valves, and appurtenances.

### 3.03 INSPECTION, TESTING AND CORRECTION OF DEFICIENCIES

- A. Do not over pressurize valves or appurtenances during pipe testing. If unit proves to be defective, it shall be replaced or repaired to satisfaction of Engineer.
- B. Functional Test: Prior to plant startup, items shall be inspected for proper alignment, quiet operation, proper connection and satisfactory performance. After installation, manual valves shall be opened and closed in presence of Engineer to show valve operates smoothly from full open to full close and without leakage. Valves equipped with electric, pneumatic or hydraulic actuators shall be cycled five times from full open to full closed in presence of Engineer without vibration, jamming, leakage, or overheating. Pressure control and pressure relief valves shall be operated in presence of Engineer to show they perform their specified function at some time prior to placing piping system in operation and as agreed during construction coordination meetings.
- C. Various pipe lines in which valves and appurtenances are to be installed are specified to be field tested. During these tests any defective valve or appurtenance shall be adjusted, removed, and replaced, or otherwise made acceptable to Engineer.
- D. Various regulating valves, strainers, or other appurtenances shall be tested to demonstrate their conformance with specified operational capabilities and deficiencies shall be corrected or device replaced or otherwise made acceptable to Engineer.

### 3.04 CLEANING

- A. Items including valve interiors shall be inspected before line closure, for presence of debris. At option of Engineer, internal inspection of valve and appurtenances may be required any time that likelihood of debris is a possibility. Pipes and valves shall be cleaned prior to installation, testing disinfection and final acceptance.

END OF SECTION 15100

## 15101 – ELECTRIC MOTOR VALVE ACTUATORS

### PART 1 GENERAL

#### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install electric valve actuators on the new valves, complete and ready for testing and operation as shown on the Drawings and as specified herein.

#### 1.02 RELATED SECTIONS

- A. Surface preparation and painting is included in Division 9.
- B. Instrumentation, not specified herein, is included in Division 13.
- C. Electrical work is included in Division 16.

#### 1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, materials required to establish compliance with this Section. The first submittal shall be the valve schedule described in Paragraph 1.09. Approval of the valve actuator schedule submittal is required prior to Contractor submitting any of the equipment in this specification. Subsequent Equipment Submittals shall include at least the following:
  - 1. Valve tag number.
  - 2. The manufacturer and supplier.
  - 3. The address at which equipment will be fabricated or assembled.
  - 4. Drawings showing assembly details, materials of construction and dimensions.
  - 5. Descriptive literature, bulletins and/or catalogs of the equipment.
  - 6. The total weight of each item.
  - 7. A complete bill of materials.
  - 8. Additional submittal data, where noted with individual pieces of equipment.
  - 9. Individual electrical control schematics and wiring diagrams for each valve operator with external interfaces, identified exactly as detailed on the Electrical and Instrumentation Drawings. Standard catalogue cut sheets that show typical wiring diagrams only are not acceptable. Valve actuators shall be coordinated with electrical requirements shown on the Drawings and valves as specified herein.
- B. Manufacturer's Installation and Application Data
- C. Operating and Maintenance Data
  - 1. Operating and maintenance instructions shall be furnished to the Engineer as specified in Division 1, Section 01730. The instructions shall be prepared specifically for this installation and shall include required cuts, drawings, equipment lists, descriptions and other information required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.04 REFERENCE STANDARDS

A. ASTM International

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
3. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
4. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
5. ASTM A436 - Standard Specification for Austenitic Gray Iron Castings.
6. ASTM A536 - Standard Specification for Ductile Iron Castings.
7. ASTM B30 - Standard Specification for Copper-Base Alloys in Ingot Form.
8. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings

B. American Water Works Association (AWWA)

1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C500 - Metal-Seated Gate Valves Supply Service
3. AWWA C504 - Rubber-Seated Butterfly Valves
4. AWWA C507 - Ball Valves, 6-in through 48-in (150mm through 1200mm)
5. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-in (50mm through 24-in (600mm) NPS
6. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service
7. AWWA C511 - Reduced-Pressure Principle Backflow-Prevention Assembly
8. AWWA C540 - Power-Actuating Devices for Valves and Sluice Gates
9. AWWA C550 - Protective Epoxy Interior Coatings for Valves and Hydrants
10. AWWA C800 - Underground Service Line Valves and Fittings

C. American National Standards Institute (ANSI)

1. ANSI B1.20.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).
2. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings
3. ANSI B16.10 - Face-to-Face and End-to-End Dimensions of Valves
4. ANSI B16.104 - Butterfly Valves

- D. American Iron and Steel Institute (AISI)
- E. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS)
  - 1. MSS-SP-61 - Pressure Testing of Steel Valves.
  - 2. MSS-SP-67 - Butterfly Valves.
  - 3. MSS-SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
  - 4. MSS-SP-71 - Cast Iron Swing Check Valves, Flanges and Threaded Ends.
  - 5. MSS-SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Services.
  - 6. MSS-SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
  - 7. MSS-SP-80 - Bronze Gate, Globe, Angle and Check Valves.
  - 8. MSS-SP-82 - Valve Pressure Testing Methods
  - 9. MSS-SP-98 - Protective Coatings for the Interior of Valves, Hydrants and Fittings.
- F. National Electrical Manufacturers Association (NEMA)
- G. Underwriters Laboratories (UL)
- H. Factory Mutual (FM)
- I. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Qualifications
  - 1. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with this Section as applicable.
  - 2. Units of the same type shall be the product of one manufacturer.
  - 3. Motor actuators shall be 480 volt, 3 Phase, 60 Hz. and shall be the product of one manufacturer. This requirement shall be coordinated with the existing valves.
- B. Certifications
  - 1. The manufacturers shall furnish an affidavit of compliance with Standards referred to herein as specified above. Refer to PART 3 for testing required for certain items in addition to that required by referenced standards.
- C. Provide the services of a qualified and factory-trained service representative of the manufacturer to provide operational and maintenance instruction, for a 1 day, 8 hour period for each type of the following equipment:
  - 1. Valve motor operators.

## 15101 – ELECTRIC MOTOR VALVE ACTUATORS

- D. Inspection of the units may also be made by the Engineer or other representative of the Owner after delivery. The equipment shall be subject to rejection at any time due to failure to meet any of the specified requirements, even though submittal data may have been accepted previously. Equipment rejected after delivery shall be marked for identification and shall be removed from the job site at once.

### 1.06 SYSTEM DESCRIPTION

- A. The equipment and materials specified herein are intended to be standard for use in controlling the flow of wastewater and air, as noted on the Drawings.
- B. Valves, appurtenances and miscellaneous items shall be installed as shown on the Drawings and as specified, to form complete workable systems.

### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Reference is made to Section 01600 for additional information.
- B. Packing and Shipping
  - 1. Care shall be taken in loading, transporting and unloading to prevent injury to the valve operators, appurtenances, or coatings. Products shall not be dropped. Valves and appurtenances shall be examined before installation and no piece shall be installed which is found to be defective. Any damage to the coatings shall be repaired as acceptable to the Engineer.
- C. Storage and Protection
  - 1. Special care shall be taken to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, to prevent deformation.

### 1.08 MAINTENANCE

- A. Special tools and the manufacturer's standard spare parts, if required for normal operation and maintenance, shall be supplied with the equipment in accordance with Section 01730 and where noted, as specified herein. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended.
- B. Provide one Operations and Maintenance manual for the valve operator supplied under this specification in accordance with Section 01730.
- C. Include within the Operations and Maintenance manuals a list of spare and replacement parts with individual prices and location where they are available.

### 1.09 VALVE DESIGNATIONS AND SCHEDULE

- A. Valves shall be identified by a unique valve tag as identified in the valve schedule prepared by the Contractor. The specific type of valve to be used will be identified by the symbol and/or call out on the Drawings. Identify each valve by its assigned tag number on shop drawings and equipment submittals.
- B. Refer to the P&IDs and Mechanical Plans for type of each valve called out by abbreviation or drawing symbol.

## PART 2 PRODUCTS

### 2.01 MATERIALS AND EQUIPMENT - GENERAL

- A. Provide special adaptors as required to ensure compatibility between valves and operators.
- B. No alternative materials will be considered for approval unless complete documentation is provided regarding their satisfactory long-term use in similar conditions; in addition, the consideration of any substitution will be considered only if the superiority of the proposed materials is the intent of the substitution, and only if sufficient evidence is provided to document that superiority.

### 2.02 VALVE ACTUATORS – POWERED

#### A. General

- 1. The actuators shall conform to AWWA Standard C540, insofar as applicable and as herein specified. Actuators shall be O-ring sealed, watertight to standard NEMA 4X/6, submersion to 6 feet for 30 minutes.
- 2. Valve service/operation shall be as indicated on the P&IDs.
- 3. 480 Volt powered actuators shall be Limitorque MX; Rotork IQ/IQM; EIM TEK 2000; AUMA SA/SAR, or Equal. Actuators shall be configured as required to provide for part turn or multi-turn and be coupled with gearboxes as required to obtain the speed and operating torque as required for the valve it controls.
- 4. Modulating actuators shall contain proportional control unit and be capable of 1200 starts per hour.

#### B. 480 Volt Powered Actuators for Multi-Turn Valve Operation

- 1. Operation
  - a. Capabilities shall be provided to position the valve (or gate) locally via the Local/Off/Remote selector switch and Open/Stop/Close push buttons.
  - b. Operators shall provide modulating service, when in remote the actuator shall accept a 4-20mADC position control signal, and shall position the valve 0-90 degrees in proportion to the control signal.
  - c. Valves shall rotate from stop to stop in 25 seconds.
- 2. Functional
  - a. The motor operated valve controller shall include the motor, operator unit gearing, limit switch gearing, limit switches, control power transformer, position transmitter (when required), torque switches, bored and key-wayed drive sleeve for non-rising stem valves, declutch lever and auxiliary handwheel as a self-contained unit. Valve contacts shall be capable of handling the current equivalent of a NEMA 1 size starter.
  - b. Reversing starters shall be integral with the actuator, and shall be solid-state starters for modulating service. Electro-mechanical reversing starters shall be acceptable for open-close service and shall be mechanically and electrically interlocked.
  - c. Limit switches and gearing shall be an integral part of the valve control. The limit switch gearing shall be made of bronze or stainless steel and shall be fully lubricated, intermittent type and totally enclosed to prevent dirt and foreign matter from entering the gear train. Limit switches shall be of the adjustable type capable of being adjusted to trip at any point between fully opened valve and fully closed valve. Limit

and torque switches shall be provided for stopping valve in both directions. Set position shall not be lost if over travel occurs in either manual or electric modes of operation.

- d. The valve position transmitter shall be a gear actuated, two-wire device, producing 4-20 mADC signal proportional to 0-90 degree valve position or to 0-100% of valve travel. The transmitter shall be provided with easily accessible zero and span adjustment potentiometers. The valve actuator shall be provided with a local digital or mechanical indicator integral with the operator with a 0-100 percent scale. The DC power supply shall be provided integral with the operator and powered from the 110 volt AC internal transformer. The positioner board shall provide repeatable accuracy to 0.25% of span. There shall be separate trim pots on the positioner board for zero, span and dead band adjustment.
  - e. The speed of the actuator shall be the responsibility of the system supplier with regards to hydraulic requirements and response compatibility with other components within the control loop. Each valve controller shall be provided with a minimum of two limit switch functions, one for opening and one for closing. Each limit switch will have two normally open and two normally closed contacts. Gear limit switches must be geared to driving mechanism and in step at all times whether in motor or manual operation. Provision shall be made for two extra sets of limit switches as described above, each to have two normally open and two normally closed contacts. Each valve controller shall be equipped with a double torque switch. The torque switch shall be adjustable and will be responsive to load encountered in either direction of travel. The limit and torque switch contacts shall be silver inlay type.
  - f. Each actuator shall include monitor relays to remotely indicate fault signal for indication of power failure, phase failure, thermal switch tripped, torque switch tripped between travel stops and Local-Off-Remote selector switch position.
3. Control/Monitoring:
    - a. The following dry contacts shall be provided for monitoring by the PLC/SCADA system
      - 1) Remote Status Indication
      - 2) Fault
      - 3) Full Opened Limit Reached
      - 4) Full Closed Limit Reached
    - b. The following analog (4-20mA) signals shall be provided
      - 1) Valve position feedback (0-100% of position)
      - 2) Valve position control (0-100% position command) for use when the valve is placed in the "Remote" mode.
  4. Physical
    - a. The operator shall be equipped with open-stop-close push-buttons, a local-off-remote selector switch and indicating lights all mounted on the operator. Where operator will not be situated between 2-ft-0-in and 7-ft-0-in above the operator platform, and where shown on the Drawings provide a separate remote valve operating station.
    - b. The motor shall operate on 460 volt, 60 hertz, 3 phase power and shall be sized by the actuator manufacturer to provide the required output torque for the service intended. The motor shall have Class F insulation, with a duty rating of at least 15 minutes at 40 degrees C ambient temperature. The motor shall be specifically designed and built by the actuator manufacturer for electric actuator service. Commercially available motors shall not be acceptable. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel regardless of the connection sequence of the power supply.
    - c. Operators utilizing multiple reduction power gearing shall consist of spur, helical, or bevel gearing and worm of hardened alloy steel, and the worm gear shall be alloy bronze. Operators utilizing single-stage reduction shall be single-stage worm gear

- totally enclosed in a fully lubricated gearcase, with filling and drain plugs. Non-metallic, aluminum, or cast gearing shall not be allowed. The output shaft shall incorporate thrust bearings of the ball or roller type at the base of the actuator.
- d. An operating wheel shall be provided for manual and/or emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to power automatically by starting the motor. The operating wheel drive must be mechanically independent of the motor drive, and any gearing shall be such as to permit emergency manual operation, using a 40 pound force in a reasonable time. Clockwise operation of the handwheel shall give closing movement of the valve unless otherwise stated.
  - e. Each actuator shall be supplied with a start-up kit including installation instructions, wiring diagrams, and spare cover screws and seals to provide for losses during commissioning.
  - f. Continuous mechanical dial indication of valve and position shall be provided. The mechanical dial position indicator shall be in step with the actuator at all times in both the hand wheel and motor operation. For modulating applications, the mechanical dial position indicator shall include graduations of 0-100 percent scale.
5. Wiring and Terminals
- a. Internal wiring shall be of tropical grade PVC insulated stranded cable of 5 amp minimum rating for control circuits and of appropriate size for the motor 3 phase power. Each wire shall be clearly identified at each end.
  - b. The terminals shall be of the stud type embedded in a terminal block of high tracking-resistance compound. The 3-phase power terminals shall be shrouded from the control terminals by means of an insulating cover.
  - c. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal. The terminal compartment of the actuator shall be provided with three threaded cable entries.
  - d. Each actuator shall be provided with a commissioning kit consisting of a wiring diagram and installation and operation manual. A separate wiring diagram shall be provided inside the terminal cover. No special tools, devices or parts shall be required for commissioning.
  - e. Actuators shall have separately sealed motor and control compartments. Operators shall have space heaters in their limit switch, motor, and control compartments.
6. Performance Test
- a. Each actuator shall be shop performance tested, and individual test certificates shall be supplied without additional charge to the Owner. Test certificates shall be submitted prior to shipment of valve actuators. The test equipment shall simulate a typical valve load, and the following parameters shall be recorded:
    - 1) No load current
    - 2) Current at maximum torque setting
    - 3) Stall current
    - 4) Torque at maximum torque setting
    - 5) Stall torque
    - 6) Test voltage and frequency
    - 7) Flash test voltage
    - 8) Actuator output speed



## 15101 – ELECTRIC MOTOR VALVE ACTUATORS

### 2.03 SURFACE PREPARATION AND SHOP COATINGS

- A. The exterior surface of various parts of valves, operators, floor-stands and miscellaneous piping shall be thoroughly cleaned of scale, dirt, grease or other foreign matter and thereafter one shop coat of an approved rust-inhibitive primer such as Inertol Primer No. 621 shall be applied in accordance with the instructions of the paint manufacturer or other primer compatible with the finish coat provided.
- B. Unless otherwise noted, interior ferrous surfaces of valves shall be given a shop finish of an asphalt varnish conforming to AWWA C509, (except mounting faces/surfaces) or epoxy conforming to AWWA C550 with a minimum thickness of 6 mils.
- C. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating. Mounting surfaces shall be especially coated with a rust preventative.
- D. Special care shall be taken to protect uncoated items and plastic items, especially from environmental damage.

### 2.04 FACTORY INSPECTION AND TESTING

- A. Factory inspection, testing and correction of deficiencies shall be done in accordance with the referenced standards and as noted herein.

## PART 3 EXECUTION

### 3.01 INSTALLATION - GENERAL

- A. Valve actuators and appurtenances shall be installed in accordance with the manufacturer's instructions in the locations shown, true to alignment and rigidly supported. Damage to the above items shall be repaired or replaced to the satisfaction of the Engineer before they are installed.
- B. Install brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings, or otherwise required. Before setting these items, check Drawings and figures which have a direct bearing on their location to ensure that valves, actuators and appurtenances are properly located during the construction of the work.
- C. Materials shall be carefully inspected for defects in construction and materials. Debris and foreign material shall be cleaned out of openings, etc. Operating mechanisms shall be operated to check their proper functioning and nuts and bolts checked for tightness. Valve operators which do not operate easily, or are otherwise defective, shall be repaired or replaced at no additional cost to the Owner.
- D. Where installation is covered by a referenced standard, installation shall be in accordance with that standard, except as herein modified. Also note additional requirements in other parts of this Section.

### 3.02 INSPECTION, TESTING AND CORRECTION OF DEFICIENCIES

- A. Do not over pressure valves or appurtenances during pipe testing. If any unit proves to be defective, it shall be replaced or repaired to the satisfaction of the Engineer.

## 15101 – ELECTRIC MOTOR VALVE ACTUATORS

- B. Functional Test: Prior to plant startup, items shall be inspected for proper alignment, quiet operation, proper connection and satisfactory performance. After installation, manual valves shall be opened and closed in the presence of the Engineer to show the valve operates smoothly from full open to full close and without leakage. Valves equipped with electric, pneumatic or hydraulic actuators shall be cycled five times from full open to full closed in the presence of the Engineer without vibration, jamming, leakage, or overheating. Pressure control and pressure relief valves shall be operated in the presence of the Engineer to show they perform their specified function at some time prior to placing the piping system in operation and as agreed during construction coordination meetings.

END OF SECTION 15101

+ + NO TEXT ON THIS PAGE + +

PART 1 - GENERAL

1.01 DESCRIPTION

- A. 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: 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 15220 – Air and Water Process Piping.

1.02 REFERENCES

- A. ANSI B16.39 - Malleable Iron Threaded Pipe Unions.
- B. ASTM F593 - Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- C. AWWA C606 - Grooved and Shouldered Joints.

1.03 QUALITY ASSURANCE

- A. Qualifications: 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.

1.04 SUBMITTALS

- A. Action Submittals: Submit the following:
  - 1. Shop Drawings: Submit piping layout Shop Drawings in accordance with Section 15220, Air and Water Process Piping.
  - 2. Product Data: 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: When requested by Engineer submit certificate attesting to compliance with standards referenced in this Section, signed by manufacturer.
  - 2. Manufacturer's Instructions: Provide instructions for handling, storing, installing, and adjusting of products.
  - 3. Source Quality Control: When requested by Engineer, submit results of source quality control tests.
  - 4. Qualifications Statements: Submit qualifications of manufacturer when requested by Engineer.

## 15120 – COUPLINGS, ADAPTERS, AND SPECIALS FOR PIPING

### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 1 section.

## PART 2 – PRODUCTS

### 2.01 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 at pipe test pressure.
    - 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.
  - 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 based on pipe service.
  - 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 at pipe test pressure.
    - 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.

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 by 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 based on pipe service.
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.

2.02 EXPANSION COUPLINGS

- A. Rubber-type Expansion Couplings:
1. General: 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.
    - 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.

2.03 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. Dielectric 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.

2.04 PAINTING

- A. Shop Painting:
1. Clean and prime-coat ferrous metal surfaces of products in the manufacturer's shop in accordance with Section 09910 - 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.

## 15120 – COUPLINGS, ADAPTERS, AND SPECIALS FOR PIPING

- B. Field painting shall conform to Section 09910 - Painting.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. Inspect materials for defects in material and workmanship. Verify compatibility of products with pipe, fittings, valves, and appurtenances.

#### 3.02 INSTALLATION

- A. Installation:
  - 1. Install piping specialties in accordance with the Contract Documents and manufacturer's instructions.
- 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 15120



+ + NO TEXT ON THIS PAGE + +

## 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 03300, Cast-In-Place Concrete.
  - 2. 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:
    - a. 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.

## 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.

## 15121 – WALL PIPES, FLOOR PIPES, AND PIPE SLEEVES

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. Wall sleeves shall be Schedule 40.
2. Shall be of sufficient size to pass the pipe and the insulation covering the pipe.
3. Shall extend 2-inches above the finished floor.
4. Shall be provided with split type escutcheon plates at the floor and wall openings.
5. Shall terminate flush with walls and ceilings.
6. Shall not be required in existing concrete walls where walls are core drilled and the resulting hole has a smooth inside surface.
7. Shall be caulked with a fire retardant caulking compound at firewalls and a gas tight caulking compound at gas tight walls.

### C. Sleeves and Wall Pipes:

1. General:
  - a. Wall pipes and wall sleeves shall be provided in accordance with the following schedule when passing through new or existing concrete or masonry structures, except where noted otherwise:

From	To	Fitting
Dry area	Wet Area	Wall Pipe
Dry area	Earth Exterior	Wall Pipe
Dry area	Dry Area	Plain Sleeve
Earth	Earth	Plain Sleeve
Exterior	Exterior	Plain Sleeve

- b. Material of construction shall be Type 316 stainless steel.

### D. Link Seals:

1. General Use: Provide link type modular 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. Seals shall continuously fill annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. Bolts and nuts shall be Type 18-8 stainless steel.
3. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and wall opening under 40 feet of head. Seal shall be suitable for a temperature range of - 40°F to 250°F and submergence in groundwater.
4. 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.

## 2.02 HOUR FIRE RATED WALL PENETRATIONS:

- A. 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.
- B. 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.

## 15121 – WALL PIPES, FLOOR PIPES, AND PIPE SLEEVES

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.
- C. 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.
- D. Pipe Seals:
1. Examination: Determine the required inside diameter of each individual wall opening or sleeve. The inside diameter of each wall opening shall be sized as recommended by the manufacturer to fit the pipe and pipe penetration seal to assure a watertight joint. Sizing for correct pipe penetration seal model and number of links per seal may be obtained through manufacturer's catalog. If pipe outer diameter is nonstandard due to coating or insulation, consult manufacturer for engineering

## 15121 – WALL PIPES, FLOOR PIPES, AND PIPE SLEEVES

assistance and recommendation before proceeding with wall opening detail.

2. Installation: Install and tighten seal to provide a watertight pipe penetration in accordance with manufacturer's instructions.

END OF SECTION 15121

PART 1 - GENERAL

1.01 - SECTION INCLUDES

- A. Small piping, valves and accessories

1.02 - SUBMITTALS

- A. Submit under provisions of Section 01300. Provide the following:
  - 1. Product literature.
  - 2. Dimensional data.
  - 3. Materials of construction specifications.

PART 2 - PRODUCTS

2.01 - STEEL PIPE AND ACCESSORIES

- A. Butt-welded, electric resistance welded, or seamless black steel pipe, ANSI 836.10, ASTM A120, Grade "B" or "A" or ASTM A53, A106, or A134 Schedule 40.
- B. Flanges, fittings, unions and similar items: Commercially available products marked in accordance with MSS-SP-25 marking on small size of odd shaped products may be omitted provided they are listed in the sequence so allowed by MSS-SP-25, but such products shall bear the manufacturer's name and trademark.
- C. Ball Valve:
  - 1. Manufacturers: Provide products of one of the following:
    - a. Victaulic Company.
    - b. Milwaukee Valve.
    - c. Or equal.
  - 2. General:
    - a. Type: Quarter turn, full port ball valve.
    - b. Sizes: Smaller than 4 Inches.

## 15140 - SMALL PIPING, VALVES AND MISCELLANEOUS EQUIPMENT

- c. Rating: 300 psig.
  - d. End Connections: NPT Threaded.
- 3. Materials of Construction:
  - a. Body: Type 316 Stainless Steel.
  - b. Ball: Type 316 Stainless Steel.
  - c. Seats: PTFE.
  - d. Stem: Type 316 Stainless Steel.
  - e. Handle, Bolts, Nuts, and Washers: Type 304 Stainless Steel.
  - f. Handle cover: Plastic.
- D. Strainers: Iron body with all wetted parts compatible with 50% caustic solution. Ball valves shall have lockable features.
- E. Fittings 2 inches and smaller: Threaded, standard cast iron.
- F. Galvanized steel pipe fittings: Same as above, except galvanized coated. Provide drainage patten type fittings for exterior gas service piping.
- G. Unions: Cast iron with bronze to iron ground joint rated at 150 lbs.
- H. Threads and dimensions: ANSI B1.1 and B18.2
- I. Thread lubricant: Crane "Formula 425", or equal. Teflon tape may be used.
- J. Gaskets: Full face, 1/8-inch thick neoprene rubber.

## PART 3 - EXECUTION

### 3.01 - INSTALLATION

- A. Joints between PVC and iron pipe shall be made with screwed fittings or screwed companion flanges.
- B. Install pipes so that expansion and contraction will not cause undue stress or strain to pipes or equipment. Provide offsets and expansion joints.

## 15140 - SMALL PIPING, VALVES AND MISCELLANEOUS EQUIPMENT

- C. Provide flanges and unions throughout the pipe systems to make installation and removal of piping and equipment convenient. Make provisions for servicing and removal of equipment without dismantling piping.
- D. Small PVC Piping Installation: Pipe and fittings in vicinity of treatment equipment and at ends of runs shall have screw type joints. In all other locations, solvent welded slip type joints will be acceptable.
- E. Threaded joints where specified shall be made using standard hand or machine pipe threaded tools. Dies must be sharp and in good condition to assure a clean and smooth threading operation from start to finish. Threads shall be full cut and perfect.
- F. Protective pads or leather, rubber or felt shall be employed to prevent damage to pipe walls by chuck and/or vise jaws. A slightly tapered wood plug shall be tapped snugly into the pipe for the length of thread to prevent distortion of the pipe wall by the die.
- G. Joints shall be made up using Teflon base compounds placed on the pipe threads. Do not place compound on threads of fittings.
- H. Wicking will not be permitted.
- I. Install PVC pipe in such a manner that it is not forced out of line by pipe supports, hangers, or other supporting members.
- J. Pipe hangers shall be clevis or strap type as specified in Section 15060.
- K. For anchoring pipe, use metal compression type hangers padded with a compressible insert band. All fittings, except couplings, shall be supported and valves shall be braced to resist torque during valve manipulation. All piping shall be free of traps and graded to permit complete drainage.
- L. Copper piping: All piping shall be cut square, burrs removed and reamed after cutting. Fitting sockets and tube ends shall be thoroughly cleaned to a bright finish. All solder joints shall be fluxed and soldered using 95-5 tin and antimony solder.
- M. Locate shutoff and control valves for easy access and operation. Where valves are located in enclosed spaces, provide access doors.

### 3.02 - FIELD QUALITY CONTROL

- A. Test small piping for pressure and leakage, in accordance with AWWA C600. Check joints for leakage while under air pressure by swabbing, utilizing soap and water solution, and leaks found



## 15140 - SMALL PIPING, VALVES AND MISCELLANEOUS EQUIPMENT

shall be repaired and rechecked.

- B. Pressure of air during testing shall be at least 50% higher than normal working pressure. Furnish all labor, materials, and equipment necessary to accomplish all testing and repairs.
- C. Before piping is concealed, recheck it for leaks.
- D. Rework or replace defective and leaking joints, and joints that are otherwise unsatisfactory. Peening, caulking and doping are not permitted.

END OF SECTION 15140

PART 1 - GENERAL

1.01 - SECTION INCLUDES

- A. Work of this Section includes all labor, materials, and equipment necessary to furnish and install air and water process piping under pressure.
- B. Work includes exposed piping as shown on the Drawings.
- C. BID NOTES (Grooved Piping Option):
  - 1. Included in the as-bid price, and at the Contractor's option, groove ended pipe and fittings may be used in lieu of flanged pipe and fittings in locations where ductile iron pipe is indicated on the Drawings or in lieu of butt-welded fittings for areas where stainless steel pipe is indicated on the Drawings, with the following provisions or except as stated herein.
  - 2. Equipment with flanged outlets and inlets, pumps, constant head boxes, valves, flow meters, and other in-line process equipment, shown on the Drawings as flanged, shall remain flanged.
  - 3. Provide and install flanged by groove ended pipe adapters for all plug, check, and butterfly valves to mate groove ended joints to flanged fittings and equipment. Groove ended valves will be permitted on this project.
  - 4. Provide a flanged by groove ended spool piece to make joints for equipment, pumps, constant head boxes, flow meters, and other in-line equipment. Spool pieces shall be at least equal to five (5) times the pipe diameter. Adapters will not be permitted in this instance.
  - 5. Where the specifications call for flanged pipe as being packaged with system equipment, this pipe shall remain as flanged.
  - 6. Groove ended stainless steel fittings will be permitted for use on compressed air lines unless otherwise noted on the Drawings. All buried and exposed stainless steel piping shall be butt-welded.
  - 7. Joint restraint using rodding, specified on the Drawings, need not be provided for groove ended pipe and fittings.
  - 8. Concrete thrust blocking, pipe restraining fittings and support piers, where shown for exposed pipe, shall be installed for either piping system.

9. All costs associated with installing piping shall be included in the bid price.

#### 1.02 - REFERENCES

- A. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- B. ANSI B36.19M – Stainless Steel Pipe
- C. ANSI/AWWA C104 - Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
- D. ANSI/AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water and Other Liquids.
- E. ANSI/AWWA - C115/A21.15 - American National Standard for Flanged Ductile Iron Pipe with Threaded Flanges.
- F. ANSI/AWWA C150/A21.50 - American National Standard for Thickness Design of Ductile Iron Pipe.
- G. ANSI/AWWA C600-93 - Installation of Ductile Iron Water Mains and Appurtenances.
- H. ANSI B18.2.1 - Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws and Lag Screws.
- I. ANSI B18.2.2 - Square and Hex Nuts (Inch Series).
- J. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- K. AWWA C606 – Grooved and Shouldered Joints.
- L. AWS D10.4 – Recommended Practices for Welding Austenitic Chromium Nickel Stainless Steel Piping
- M. ASTM A312/A312M – Seamless and Welded Austenitic Stainless Pipes

#### 1.03 - SUBMITTALS

- A. Submit information in accordance with Section 01300.
- B. Prepare a schedule for each service classification specified herein listing the pipe, fitting, lining, coating and joint type proposed for the project.

- C. Provide data on pipe material, coatings, linings, pipe fittings, dimensions and accessories. Provide manufacturer's catalog information.
- D. Piping shop drawings shall be provided. Field measurement then on-site fabrication of pipe will not be permitted. All exposed pipe shall be delivered to the site cut to exact layout dimensions.
- E. Manufacturer's installation instructions for each pipe type.
- F. Foundry Records and Tests for ductile iron pipe: Written transcripts of the test results shall be delivered directly to the Engineer within one week of the shipment of pipe with the date of the tests as close to the date of manufacture as practical. For ductile iron pipe, written transcripts shall be furnished directly to the Engineer in accordance with applicable sections of AWWA C151 and ANSI A21.51:

Transcripts & Certification: 51-5.2

Group Tests Required: Hydrostatic Test (51-9)  
Tensile Test (51-12.1)  
Impact Test (51-12.2)

Low Temperature Impact Test (51-13)

Number of Specific Group Tests Required in Addition to General Certification: One (1) per pipe size per 2,000 linear feet of pipe.

- G. Certifications for stainless steel piping specified in the following documents:
  - 1. ASTM A403, paragraph 14.1
  - 2. ASTM A774, paragraph 14.1
  - 3. ASTM A778, paragraph 14.1
  - 4. ASTM A409, paragraph 17.1
- H. Names and qualification records of proposed welders.
- I. Other data necessary to show conformance of the stainless steel piping system to these specifications.

#### 1.04 - QUALITY ASSURANCE

- A. All piping manufacturers shall meet ISO 9001:2000.

- B. Ductile iron pipe manufacturer shall be a member of the Ductile Iron Pipe Research Association.
- C. Ductile iron pipe shall be marked with the manufacturer's name, classification, or nominal thickness and "DI" or "Ductile Iron".
- D. Stainless steel pipe shall be marked with manufacturer's name, gauge, or nominal thickness and heat rating.
- E. All shop fabricated stainless steel pipe and fittings shall be furnished by a single manufacturer who is experienced and qualified in the manufacture and fabrication of the items to be furnished.
- F. The pipe and fittings shall be shop-fabricated and field-installed in accordance with common industry wide practices and methods and shall comply with these specifications.
- G. Only weld procedures which have been qualified under ASME Section IX and only welders who have successfully completed performance qualification tests per ASME Section IX on these qualified procedures shall be utilized.
- H. The stainless steel piping supplier and the Contractor shall use extreme care to avoid the contact of any ferrous materials with the stainless steel piping during manufacturing, fabricating, handling, and installation stages.
- I. All saws, drills, files, and wire brushes shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be nonferrous, stainless steel, or rubber-lined.
- J. Nylon slings or straps shall be used for handling stainless steel piping. After installation, the Contractor shall wash and rinse all foreign matter from the piping surface.
- K. All welded joints shall be treated with a pickling solution, brushed with stainless steel wire brushes, and rinsed clean. If rusting of embedded iron occurs, the Contractor shall pickle the affected surface with Oakite Deoxidizer SS, or equal, scrub with stainless steel brushes, and rinse clean.
- L. Factory testing of stainless steel piping shall conform to the requirements of ASTM A312, ASTM A409 HT-0, or ASTM A778, depending on the size and type of stainless steel pipe provided.

#### 1.05 - DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products in accordance with manufacturer's instructions.
- B. Fabricated piping shall have openings plugged and flanges secured for storage or transport after fabrication.

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- C. Fabricated piping shall be piece-marked with identifying numbers or codes which correspond to the Contractor's layout and installation drawings. The marks shall be located on the spools at opposite ends and 180° (degrees) apart.
- D. Pipe spools shall be loaded, blocked, and lagged as necessary to ensure protection from damage during shipping.
- E. Stainless steel pipe and fittings shall be stored per manufacturer's recommendation.
- F. Dents, gouges, and scratches in stainless steel pipe and fittings are not acceptable and are reason for rejecting pipe and fittings.
- G. Protect products from entry of foreign materials.

### 1.06 - ENVIRONMENTAL REQUIREMENTS

- A. Do not install piping when bedding is wet or frozen.

## PART 2 - PRODUCTS

### 2.01 - DUCTILE IRON PIPE AND FITTINGS – BURIED AND EXPOSED

- A. Ductile iron pipe shall be centrifugally cast with primary graphite in nodular form or spherulitic and conform to AWWA C151.
  - 1. All buried and exposed (dry and submerged service) shall be thickness Class 53.
  - 2. Grooved end ductile iron pipe shall conform to AWWA C606 and manufactured to rigid groove dimensions.
  - 3. All buried and exposed ductile iron pipe and fittings shall be cement lined in accordance with AWWA C104, double thickness, minimum  $\frac{3}{16}$ " for pipe and standard thickness for fittings.
  - 4. All buried ductile iron pipe and fittings shall be provided with bituminous seal coat in accordance with AWWA C106, inside and out.
  - 5. All exposed (dry and immersion service) ductile iron pipe shall be provided with an interior seal coat in accordance with AWWA C106. The exterior of all exposed ductile iron pipe shall be factory primed using a high solids epoxy system with a shop coat thickness of 3.0-8.0 mils DFT. The primer shall be manufactured by Tnemec Company

or equal and be red oxide in color. Field paint exposed ductile iron pipe (dry and immersion service) as specified in Section 09910.

B. Fittings: Comply with AWWA C110 for center-to-center end dimensions.

1. Buried: All buried fittings and buried valve joints shall be mechanically restrained and be provided with thrust blocking as detailed on the Drawings. Mechanical joint restraint shall be incorporated into the design of the follower gland. The restraining mechanism shall consist of individually actuated wedges. The joint restraint ring shall be made of 60-42-10 ductile iron conforming to ASTM A536. The restraint shall be series 1100 Megalug by Ebba Iron or equal.
2. Exposed:
  - a. Ductile iron flanged fittings shall match those of Class 125 flanges in accordance with ANSI B16.1 with  $\frac{1}{8}$ -inch full-face plain rubber SBR (Styrene Butadiene Copolymer) gaskets for sewage and water service.
  - b. Ductile iron grooved fittings shall comply with AWWA C606 rigid radius grooving dimensions. Fittings shall be ductile conforming to ASTM A536.

C. Joints:

1. Exposed Piping:
  - a. Flanged: shall be as specified above for fittings.
  - b. Grooved: shall be Victaulic Style 31 or equal, cast of ductile iron conforming to ASTM A-536 with alkyd-phenolic primer coating with a synthetic rubber gasket suitable for the intended service. Gasket shall be specially compounded to conform to ductile iron pipe surfaces with a short center leg that shall bridge the pipe ends offering an initial seal on the leading edge of the pipe ends.
2. Buried Piping: AWWA C111 push on joint with stainless steel locking segments vulcanized into rubber ring gasket, Flex-Ring<sup>®</sup> by American Ductile Iron Pipe or FieldLok<sup>®</sup> by U.S. Pipe or equal.

D. Exposed and Buried Service Bolts and Nuts: Nuts and bolts shall be alloy steel conforming to the physical properties of ASTM A563. Bolts shall conform to ANSI B18.2.1. Nuts shall conform to ANSI B18.2.2. Bolts and nuts for grooved pipe shall be heat-treated plated carbon steel, track

head, conforming to the physical properties of ASTM A183. Paint exposed and buried bolts and nuts in accordance with Section 09910.

- E. Submerged Service Bolts and Nuts: Type 304 stainless steel conforming to ASTM A-193. All piping bolts and nuts located in any tank, vault, well, chamber, or any other structure that treats, stores or conveys water or sewage shall be considered a submerged (immersion) service even if it is not physically located below the water level. The Contractor shall not paint these nuts and bolts. Mask the exposed threads prior to pipe painting. All bolts and nuts in any process tank, regardless if it is located above water level shall meet the requirements of this paragraph.
- F. Lubricant for Joints: Shall have no deteriorating effects on gasket or pipe material and shall be supplied by the pipe manufacturer or joint manufacturer in sufficient quantity.
- G. Manufacturer: American Ductile Iron Pipe, U.S. Pipe & Foundry Co. or equal.
- H. Flanged Adapters: Dismantling joint Smith Blair, Inc., Model 975 or equal for plain end steel or cast iron pipe with all bolts, rings, gaskets and accessories.
- I. Couplings: Smith Blair, Inc., Model 411 or equal for plain end steel or cast iron pipe with all bolts, rings, gaskets and accessories.
- J. Restrained Joint Fittings: Ford Meter Box Co., Inc., UNI-FLANGE "BlockBuster" series 13100, 1400 & 1500 for PVC, ductile iron and steel piping.

## 2.02 – STAINLESS STEEL PIPE AND FITTINGS – BURIED AND EXPOSED

- A. Stainless steel pipe shall be Type 304L stainless steel, with 2D finish in compliance with AISI 304L and ASTM A240. Pipe shall be manufactured to nominal pipe sizes as listed in ANSI B36.19 and shall have nominal wall thicknesses corresponding to schedule 10 for above grade and schedule 40 for below grade. Only extra-low carbon (ELC) materials with 0.030% maximum carbon shall be used.
- B. All connections shall be welded in compliance with AWS D10.4, except as otherwise shown on Drawings.
- C. Fittings:
  - 1. Unless otherwise specified, stainless steel fittings 3-inch and larger: butt weld type manufactured in accordance with ASTM A774 of the same material and in the same thicknesses as the pipe. Long radius elbows less than 24-inches in diameter shall be smooth flow. All short radius, special radius, reducing, and long radius elbows 24-inches



and greater in diameter shall be of mitered construction. Reducers shall be straight tapered cone type. Tees, crosses, laterals, and wyes shall be shop-fabricated from pipe.

2. Flanged fittings: match those of Class 125 flanges in accordance with ANSI B16.1.
  3. Gaskets: Viton with a temperature capability of 350 deg. F.
  4. Bolts nuts and washers for stainless steel flange assemblies: Type 316 stainless steel with bolts and nuts conforming to ASTM A193 Grade B8M.
- D. Pipe support systems: include all hangers, rods, structural attachments, and other components of support systems for stainless steel pipe shall be of the same materials as the pipe.
- E. Finishing: After all shop operations have been completed, pipe and fittings shall be pickled and passivated in the manufacturer's plant, and scrubbed and washed until discoloration and possible iron picked up from manufacturing process are removed. The standard finish for 16-gauge through 8-gauge material shall be No. 1 or 2B per ASTM A480; 3/16-inch and heavier plate material shall be No. 1-mil finish or better per ASTM A480.

### PART 3 - EXECUTION

#### 3.01 - BURIED PIPE INSTALLATION – GENERAL

- A. Install pipe in accordance with the manufacturer's written instructions and in accordance with applicable AWWA and ANSI standards.
- B. Comply with the excavation, backfill, compaction, and dewatering requirements in Division 2 of these specifications for installation of buried pipe.
- C. Keep buried piping clean as it is being installed by plugging the open end. Do not allow foreign material, such as soil and groundwater, from entering the pipe. If directed by the Engineer, the Contractor shall water flush installed pipe to remove foreign material. Water used to flush pipe shall be trucked to the site by the Contractor. Use of site water will not be allowed. The Owner will not pay for water usage in this regard.
- D. Maintain the excavation free of water during the progress of the work. No pipes shall be installed in water nor shall any joints be made in water. All slides or cave-ins of trenches or cuts shall be remedied prior to the work continuing.
- E. Commence pipe laying at the lowest point, with the bell or socket end pointing in the direction of flow.

- F. Use the manufacturer's approved equipment for cutting pipe to length.
- G. Thoroughly clean pipe and fitting interiors, joint surfaces, and gaskets prior to them being placed in the trench for installation. Maintain all materials clean during the prosecution of the work.
- H. Carefully lower pipes and fittings into the trench using industry recognized rigging standards and techniques. Every joint shall be made in the trench.
- I. All adjustments to the line and grade of pipe laid in earth foundation shall be done by scraping away or filling in the earth under the barrel of the pipe, and not by blocking or wedging. Where the excavation has been carried too deep, but not in excess of six (6) inches, the Contractor may replace with suitable material and mechanically compact to provide a firm foundation. Wherever, the excavations have been carried to a depth in excess of six (6) inches, the Engineer may order stone or gravel refill without additional compensation. In all cases, the trench under the joint shall be excavated to permit an even bearing for the barrel of the pipe.
- J. When unsuitable materials are encountered, the Engineer may direct the Contractor to continue the excavation below the required elevation and the trench filled with suitable material. This work will be paid for as "Extra Work".
- K. Stainless steel pipe cutting, threading and jointing shall conform to the requirements of ANSI B31.1. All pipe threads shall be lubricated with Teflon tape.

### 3.02 – STAINLESS STEEL PIPE INSTALLATION – GENERAL

- A. Piping with wall thickness up to 11-gauge (0.120-inch): welded with the TIG (GTAW) process. Unless otherwise specified, heavier walls shall 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. Filler wire of ELC grades only shall be added to all welds to provide a cross section at the weld equal to or greater than the parent metal. Weld deposit shall 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. Concavity, undercut, cracks, or crevices shall not be allowed. Butt welds shall have full penetration to the interior surface, and inert gas shielding shall be provided to the interior and exterior of the joint. Excessive weld deposits, slag, spatter, and projections shall be removed by grinding. Welds on gasket surfaces shall be ground smooth.
- B. Field welding; minimized to the greatest extent possible by prefabrication of pipe systems at the factory. Pipe butt welds may be performed at the job site providing the butt welds are performed only with an inert gas shielded process and that other applicable specified welding requirements are rigidly adhered to. All residue, oxide, and heat stain is to be removed from any type of field weld and the affected adjacent areas by the use of stainless steel wire brushes. The field weld

shall then be cleaned with an agent such as Eutectic Company's "Eucleen" or equal followed by complete removal of the agent.

- C. Preparation of Surfaces to Be Welded shall be free from mill scale, slag, grease, oil, paint, rust, and other foreign material.
- D. Joints to be welded shall be wire-brushed with stainless steel wire brushes and precisely fitted before welding.
- E. Welding shall be done only when the surfaces are completely free of any moisture. Welding of the pipe shall not be done during periods of high winds or rain unless the areas being welded are properly shielded.
- F. Nicks, gouges, notches, and depressions in the base metal in the area of the joint shall be repaired before the joint weld is made. Tack welds, clips, and other attachments shall be removed and defects repaired, except where the tack welds occur within the weld area and these tack welds do not exceed the size of the completed weld. Cracked tack welds shall be removed. Areas to be repaired shall be ground to clean metal and then repaired by building up with weld metal. The repaired areas shall be ground smooth to form a plane surface with the base metal.
- G. Welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient in quality or made contrary to any provisions of these specifications shall be removed by chipping or grinding throughout their depth to clean base metal. Calking or peening of welds to correct defects shall not be done. Welds found deficient in dimension but not in quality shall be enlarged by additional welding after thoroughly cleaning the surface of previously deposited metal and the adjoining plate. Weld deposits, slag, weld spatter, and projections into the interior of the pipe shall be removed by grinding.

### 3.02 - BURIED PIPE/FITTING INSTALLATION – MECHANICAL/RESTRAINED JOINT

- A. Comply with the manufacturer's written instructions for installing ductile iron pipe, fittings and retainer.
- B. Clean the socket and plain end. All surfaces with which the gasket comes in contact shall be thoroughly wire brushed just prior to assembly. All loose rust, mud, frozen material, sand, gravel, and other foreign material shall be removed.
- C. Wipe the gasket clean and install the gasket. Take care that no gasket loops or bulges protrude into the path of the entering pipe spigot. In temperatures below 32 degrees F, warm gaskets before installation.

- D. Using a clean brush, apply a liberal amount of lubricant completely over the end of the pipe, the spigot radius, and the outer surface of the pipe up to the assembly stripe. Also, apply lubricant completely over the exposed surface of the gasket.
- E. Install the bevel end of the pipe into the socket. Take care that the plain end is centrally located in the socket and push the pipe home. The joint deflection may then be set.
- F. When tightening bolts on mechanical joint fittings, the gland shall be brought up to the fitting flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around. This shall be done by partially tightening the bottom bolt first then the top bolt, next the bolts at either side, and last the remaining bolts. Repeat this process until the proper joint tightness is achieved and the nut is sheared off. Overstressing the bolts to compensate for the poor installation will not be permitted.
- G. Complete the installation by applying a single coat of bitumastic to the entire surface of the retainer.

### 3.03 - EXPOSED PIPING

- A. Flanged: Clean face of flange of all sand, grease, grit or other foreign matter. Center gasket before assembling joints. After alignment has been completed insert bolts and hand tighten nuts. Keep gap between flanges approximately uniform while tightening. Tighten bolts to required torque in several steps, alternating from one side to the other.
- B. Grooved:
  - 1. Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing.
  - 2. A thin uniform coat of lubricant, provided by the joint manufacturer, shall be applied to the gasket, coupling or housing using a clean brush.
  - 3. The gasket and coupling housing shall be installed as contained in the manufacturer's written instructions.
- C. Install flanged adapters and couplings in accordance with manufacturer's installation instructions.

### 3.04 - RECHECKING AND REPAIRING

- A. Pressure test all exposed and underground pipe in accordance with the requirements contained in Division 1. Before piping is concealed, recheck for leaks.

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- B. Rework or replace defective and leaking joints, and joints that are otherwise unsatisfactory. Peening, caulking and doping are not permitted.

### 3.05 - FIELD QUALITY CONTROL

- A. Conduct pressure testing in accordance with AWWA C600 and Division 1 requirements.
- B. Blow out all dirt, debris and foreign material in all aeration process piping before placing the aeration system diffusers on-line. Do not use water to flush out material. The use of the supplied air compressors may be used if approved by the Engineer.

END OF SECTION 15220

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

- 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 WASHDOWN CORROSION RESISTANT ELECTRIC UNIT HEATERS

- A. Electric unit heater shall be Chromalox Model HD3D or approved equal.
- B. Heaters capacities and electrical characteristics shall be as called for on the equipment schedules. Heaters shall be forced fan hose-down corrosion resistant type.
- C. The heating elements shall be type 316 stainless steel of finned tubular construction with stainless steel fittings.
- D. The motor shall be UL listed, totally enclosed with permanently lubricated ball bearings, designed to resist moisture and corrosion, fitted with an epoxy coated fan blade and factory wired to NEMA 4X stainless steel enclosure.
- E. Heating elements and motor shall be enclosed in a round heavy 20 gauge stainless steel shroud, with stainless steel louvered outlet grille and plated rear grille.
- F. Each unit shall be provided with a NEMA 4X enclosure to house element terminals and following controls:
  - 1. Automatic reset overtemperature outlet,
  - 2. Fan delay relay,
  - 3. Heater contactor
  - 4. Motor contactor
  - 5. Terminal block for field wiring by the Contractor.
- G. Supports: Factory provided swivel bracket suitable for wall mounting.
- H. All options and accessories shall be as called for on the equipment schedules.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Install unit in accordance with manufacturer's published installation instructions.

- B. Do not install horizontal unit heaters closer than 12 inches to combustible materials in any direction. Follow any additional clearance requirements as per manufacturer's instructions.

**END OF SECTION**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Provide exhaust fans, as specified herein, of sizes and capacities scheduled and in locations shown on drawings.

1.02 REFERENCE

- 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. Certified AMCA Ratings - Submit ratings for air and sound performance.
- E. 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 or integral outlet dampers, inlet screens, outlet velocity heads or drive losses.
- 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 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.

#### 1.05 WARRANTY

- A. The warranty of this equipment is to be free from defects in material and workmanship for a period of 1 Yr after installation and acceptance by Owner. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer, transportation prepaid
- B. Motor Warranty is warranted by the motor manufacturer for a period of one year. Should motors furnished by us prove defective during this period, they should be returned to the nearest authorized motor service station

### PART 2 – PRODUCTS

#### 2.01 DIRECT DRIVE INLINE FANS

- A. General Description:
  - 1. Fans shall be model SQ centrifugal inline fans by Greenheck or equivalent.
  - 2. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.
  - 3. All options and accessories shall be as called for on the equipment schedules.
- B. Wheel:
  - 1. Non-overloading, backward inclined centrifugal wheel
  - 2. Constructed of Aluminum
  - 3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
  - 4. The wheel cone and fan inlet shall be matched and shall have precise running tolerances for maximum performance and operating efficiency
  - 5. Single thickness blades shall be securely riveted or welded to a heavy gauge back plate and wheel cone
- C. Motors:
  - 1. Electronically Commutated Motor
    - a. Motor enclosure: As called for on equipment schedules.
    - b. Motor shall be a DC electronic commutation type motor (ECM) specifically designed for fan applications.
    - c. Motors shall be permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase
    - d. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor
    - e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal, as called for on the schedules and sequence of operations.
    - f. Motor shall be a minimum of 85% efficient at all speeds
- D. Housing/Cabinet Construction:
  - 1. Square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars
  - 2. Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly.

## 15831 - EXHAUST FANS

### E. Housing Supports and Drive Frame:

1. Housing supports shall be constructed of structural steel with formed flanges
2. Drive frame shall be welded steel and shall support the motor

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. The fan shall be connected and installed as shown on the drawings and in accordance with the manufacturer's printed instructions.

### 3.02 GENERAL

- A. Install fans, including all necessary structural supports and bracing as scheduled and located on the contract drawings 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.

### 3.03 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 and maintenance of equipment.
- E. Each fan shall be dynamically balanced at the specified operating speed.

END OF SECTION 15831

+ + NO TEXT ON THIS PAGE + +

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section describes the ductwork for HVAC duct systems 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 REFERENCES

- A. ASHRAE - Handbook Fundamentals; Latest Edition.
- B. SMACNA - HVAC Duct Construction Standards Metal And Flexible (latest issue)
- C. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- D. New York State Mechanical Code.

1.03 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A and New York State Mechanical Code standards.

1.04 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. Access doors.
  - 4. Flexible connections.
  - 5. Other accessories.

## 1.05 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 on the Drawings. If not shown, the pressure classification shall be greater than or equal to the maximum operating static pressure (minimum 2" w.c. pressure classification).
- 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.

## PART 2 - PRODUCTS

### 2.01 STAINLESS STEEL RECTANGULAR DUCTS AND FITTINGS

- A. Construct ducts in accordance with the latest SMACNA HVAC Duct Construction Standards Metal And Flexible and pressure classifications as stated on the Drawings (minimum 2" w.c. pressure classification).
- B. No ducts shall be less than No. 22 U.S. Gauge, type 316 stainless steel.
- C. Use stainless steel fasteners.
- D. Use stainless steel reinforcing members.
- E. 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.
- F. Provide 90-degree full-radius elbows with a centerline radius 1.5 times the duct width in the plane of the bend.
- G. For elbows with centerline radius less than 1.5 times the width of the duct in the plane of the bend, provide turning vanes.
- H. Provide square throat elbows with manufactured turning vanes.
- I. 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.
- J. For split fittings, the split shall be proportional to the air flow. Construct per SMACNA HVAC Duct Construction Standards- Metal and Flexible.
- K. 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.
- L. All branch take-offs perpendicular to the main shall be a 45 degree entry.
- M. Longitudinal seams shall be of the Pittsburgh Lock type outlined in the SMACNA HVAC Duct Construction Standards Metal and Flexible.

- N. 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. Fabricate all 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 with continuous neoprene gaskets around perimeter of access doors for airtight seal.
- D. Provide all access doors with cam lock latches.
- E. Provide access doors in following locations:
1. In-Line Fans (suction and discharge sides)

## 2.04 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, airtight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

## 2.05 DUCT HANGERS AND SUPPORTS

- A. Provide trapeze, strap or angle iron hangers meeting SMACNA HVAC Duct Construction Standards Metal and Flexible.
- B. Materials of hangers, supports and fasteners shall conform to the manufacturer's load ratings.

- C. Hangers, supports, upper attachments and inserts shall be stainless steel.
- D. Fasteners for HVAC duct systems shall be stainless steel.
- E. Secure ductwork hangers attached to concrete structures and slabs with embedded inserts, anchor bolts or concrete fasteners. A safety factor of 5 should be used in selection of all inserts and expansion bolts (if applicable safety factor shall be determined by analysis of seismic loads and the greater safety factor shall be used).
- F. Provide hangers and supports not more than 12 inches from each face of a horizontal elbow.
- G. Plenums shall be supported to permit personnel to enter the plenum. If no structural steel design is shown on the Drawings, it is the responsibility of the Contractor to provide the services of a licensed structural engineer in the in which the project is to be constructed to submit a structural design for review.

## 2.06 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.

## 2.07 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 and where vibration will be transmitted through ductwork.
- D. Approved Manufacturers:
  - 1. "Ventglas" by Vent Fabrics, Inc.

## 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. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

### 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. Support ductwork hung from building structure using trapeze, strap or angle iron hangers conforming to SMACNA HVAC Duct Construction Standards Metal and Flexible. Provide supplemental structural steel to span joists where required.
- 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. Fasten plenums and casings connected to concrete curbs using continuous 1 ½ inch by 1 ½ inch by ¼ inch galvanized steel angle support. Set the angle support in a continuous bead of caulking compound and anchor it to the curb with 3/8 inch diameter anchors on 16 inch centers. Terminate sheet metal at curb and bolt to angle support. Seal sheet metal to curb with a continuous bead of caulking.
- H. 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 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
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.

### 3.06 DUCTWORK MATERIAL SCHEDULE

AIR SYSTEM	DUCTWORK MATERIAL
Exhaust ductwork	Type 316 Stainless Steel

END OF SECTION 15890

PART 1 - GENERAL

1.01 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. 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.
  - 3. 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. All existing plants 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 process, 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 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 Owner 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.

1.02 RELATED SPECIFICATIONS

- A. Specification 09910 – Painting.
- B. Specification 16036 – Testing

1.03 PAYMENT

- A. Payment for general electrical requirements shall be made as provided for in the Specifications.

1.04 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.

#### 1.05 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 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.

#### 1.06 QUALITY ASSURANCE

- A. General:
  - 1. All equipment and devices 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 Engineer Approved 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. For this Contract NEMA 4X areas include but are not limited to the East and West Pipe Galleries, the Final Sedimentation Tank Distribution Boxes, the below grade tunnels, and all exterior locations.
    - 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. For this Contract, hazardous areas include but are not limited to the influent wet well area within the Headworks Building.

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- c. Materials, equipment and incidentals installed in non-corrosive and non-hazardous areas shall meet NEC and NEMA 12 requirements. For this Contract NEMA 12 areas include but are not limited to the Control Building.

### 1.07 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. 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.
- D. 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.
- E. 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.
- F. 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 thirty (30) 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.

### 1.08 PRIOR, CURRENT AND FUTURE CONSTRUCTION CONTRACTS

- A. Refer to Specification 01010 – Summary Work

### 1.09 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

## 16010 – GENERAL ELECTRICAL REQUIREMENTS

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.

- B. Refer to Specification 01310 – Maintenance of Plant Operations.

### 1.10 TEMPORARY FACILITIES

- A. Temporary facilities shall be provided in accordance with the requirements of Paragraph 1.9, Sequence of Construction and Operation.
- 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.

### 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 thirty (30) 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. Existing Cables and Conduits

1. 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.
2. 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.
3. 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.
4. 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.
5. The Contractor's attention is directed to the requirement that he shall work on an existing Sewage Plant which shall remain in operation.
6. 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.
7. 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.
8. 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.
9. 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.

## 16010 – GENERAL ELECTRICAL REQUIREMENTS

- E. Emergency Repair Crews: In case the Contractor's operations disrupt the process at any of the, 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

#### 2.01 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.

#### 2.02 SHOP FINISHES

- A. Electrical equipment shall be shop painted.
- 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.
- D. Other equipment shall be painted with the manufacturer's best grade finish paint system compatible with the finish coatings specified.

### PART 3 - EXECUTION

#### 3.01 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 Paragraph 1.09 of this specification.
- 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.

## 16010 – GENERAL ELECTRICAL REQUIREMENTS

- 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 Owner 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.

### 3.02 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 demonstration of equipment shall include the following:
  - 1. All power circuits shall be operated to verify proper connection to equipment.
  - 2. 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.
  - 3. 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.
  - 4. All instrumentation systems shall be operated to verify that wiring and data transmission is correct.

### 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.

END OF SECTION 16010



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## PART 1 - GENERAL

### 1.01 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.

### 1.02 PAYMENT

- A. Payment for demolition work shall be made as provided for in the Specifications.

### 1.03 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

### 1.04 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. Techniques and details proposed to accomplish the demolition work.

### 1.05 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 workers for the various types of demolition and removal work. All patching, replacing and refinishing of work shall be done by skilled workers. The work shall be carried out through to completion with due regard to the safety of County employees, workers 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.

#### 1.06 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.

#### 1.07 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

##### 3.01 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, workers 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 local 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.

### 3.02 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.

## 16035 – DEMOLITION ELECTRICAL

- 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 Contract Documents. 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.

### 3.03 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 16035

PART 1 – GENERAL

1.01 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.

1.02 RELATED SPECIFICATIONS

- A. Specification 16292 - Power Distribution System Coordination

1.03 REFERENCES

- A. NETA - International Electrical Testing Association.
- B. IEEE - Institute of Electrical and Electronics Engineers.
- C. ANSI - American National Standards Institute.

1.04 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: 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.

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.

1.05 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 16036

PART 1 - GENERAL

1.01 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 and grounding electrodes.

1.02 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. PSEG Long Island.
  - 3. UL Standard No. 467, Electrical Grounding and Bonding Equipment.

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 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.

1.06 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.

1.07 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

### 2.01 GROUND CABLE

- A. The ground cable shall be soft drawn bare stranded copper conforming to ASTM B8 and B189. Size shall be 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, Southwire, or equal to be approved by the Engineer.

### 2.02 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.

### 2.03 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

### 3.01 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

## 16061 – GROUNDING

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.

### 3.02 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 in accordance with NEC 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 16061

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PART 1 – GENERAL

1.01 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.
- C. This section also includes equipment anchorage and restraints suitable to meet the specified seismic requirements.

1.02 RELATED SPECIFICATIONS

- A. Specification 16131 - Electric Conduit System

1.03 PAYMENT

- A. Payment for supporting devices shall be made as provided for in the Specifications.

1.04 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.

1.05 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. 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.

1.06 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 and stamp support details for equipment exceeding 50 pounds in weight.
- 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 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.

#### 1.07 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

#### 2.01 MANUFACTURERS

- A. Supporting devices shall be by B-Line (Eaton), Kindorf (Thomas & Betts/ ABB Group), or equal to be approved by the Engineer.

#### 2.02 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.

### 2.03 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

### 3.01 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 16071

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## PART 1 - GENERAL

### 1.01 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 labelling 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.

### 1.02 RELATED SPECIFICATIONS

- A. Specification 16121 - Electric Wire and Cable
- B. Specification 16131 - Electric Conduit System

### 1.03 PAYMENT

- A. Payment for labeling and identification shall be made as provided for in Division 1 of the Specifications.

### 1.04 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.

### 1.05 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. 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.

### 1.06 QUALITY ASSURANCE

- A. All labeling and identification signs and nameplates shall be provided in accordance with the NFPA 70 and OSHA.



## 1.07 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

### 2.01 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.

### 2.02 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 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.
- C. Nameplates for distribution equipment shall have the following information:
  - 1. Equipment name and number.
  - 2. Voltage.
  - 3. Phases and number of wires.
- D. Pullboxes, junction boxes and control stations shall have a nameplate identifying the equipment name and number.
- E. 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 identify the served equipment name and number.
- F. All control and indicating devices shall have individual nameplates identifying device function.
- G. Nameplate mounting screws shall be 3/16 inch diameter, round-head, stainless steel self-tapping type. Adhesives shall not be used.

### 2.03 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.

## 16076 - LABELING AND IDENTIFICATION

### 2.04 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

### 3.01 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 16076

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## 16121 - ELECTRIC WIRES AND CABLES

### PART 1 - GENERAL

#### 1.01 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 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.

#### 1.02 PAYMENT

- A. Payment for electric wires and cables shall be made as provided for in Division 1 of the Specifications.

#### 1.03 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.

#### 1.04 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. Prior to equipment submission, a list of proposed manufacturers shall be submitted with the products they produce proposed for the contract.

## 16121 - ELECTRIC WIRES AND CABLES

2. Manufacturer's Literature, specifications and engineering data for the electric wires and cables and accessories.
  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.
  4. 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. Reports:
1. Shop and field test reports shall be submitted.
  2. Acceptance testing report shall be submitted.
- D. SAFETY DATA SHEETS
1. Safety and Data Sheets (SDS) shall be submitted for all cables and wires supplied. SDS shall be submitted with the equipment shop drawings.

### 1.05 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. 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.
  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.
- 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.

### 1.06 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

### 2.01 300 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.

## 16121 - ELECTRIC WIRES AND CABLES

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 local 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.

### 2.02 600 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, Southwire, or equal to be approved by the Engineer.
- C. When identified on the Contract drawings 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.

2.03 600 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 `
  - 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.

## 2.04 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.

### 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.

## 2.05 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.

## 2.06 FIBER OPTIC CABLES (OM4)

### A. Fiber optic cable shall be installed for inter-building and inter-panel communication as shown on drawings. These cables shall meet the following:

1. Cable shall be suitable for installation as both trunk cable and riser cable.
2. Cable shall be rated for indoor/outdoor use.
3. Cable shall be 50/125 micrometer (core/clad) multimode fiber optic cable.
4. Cable shall utilize a multi-fiber per tube (MFPT) design consisting of 12 fibers (6 pairs) contained in tight buffer tubes.
5. Cable shall be riser rated distribution cable.
6. Cable shall have a ripcord(s) to assist in jacket removal.
7. Cable shall be suitable for direct termination with standard connectors.
8. Manufacturer:



## 16121 - ELECTRIC WIRES AND CABLES

- a. Corning Cable Systems
  - b. Belden Cable
  - c. Black Box
  - d. Approved equal
- B. Fiber Optic Patch Cables
- 1. Patch cables shall be 50/125 micrometer (core/clad) multimode riser rated fiber optic cable.
  - 2. Patch cables shall be terminated with type LC connectors.
  - 3. Manufacturer:
    - a. Optical Cable Corporation
    - b. Siecor
    - c. Approved equal

### 2.07 FIBER OPTIC DISTRIBUTION UNIT

- A. Provide a DIN rail mountable fiber distribution unit.
- 1. Connectors
    - a. External Interface: Three (3) LC quad connectors
    - b. Internal Interface: Three (3) LC quad connectors
    - c. Supported Cable Types: OM3, OM4
  - 2. Specifications
    - a. Standards: UL Listed 1863
    - b. Operating Temperature: -40 degrees C to +75 degrees C
    - c. Storage/Transport Temperature: -40 degrees C to + 80 degrees C
    - d. Relative Humidity (non-condensing): 10% to 95%
    - e. Insertion Loss: Less than or equal to .3dB (Multimode), less than or equal to .2dB (Singlemode)
    - f. Plug/Unplug Durability: 1000 times
  - 3. Mechanical Construction
    - a. Dimensions With Adapters Installed: 6.25"H x 2.75"W x 5.125"D
    - b. Mounting Options: Rear DIN-Rail, Side DIN-Rail
    - c. Weight: 1.5 lbs
    - d. Protection Class: IP20
  - 4. Materials of Construction
    - a. Patch Panel Body and Faceplate: 18 gauge powder-coated painted steel
    - b. Fiber Optic Adapters: UL 90 V-0 Thermoplastic
    - c. Cable Glands: Plastic with maximum cable diameter of 14mm
  - 5. Warranty
    - a. Lifetime warranty on materials and workmanship
  - 6. Manufacturer
    - a. DINSpace model SNAP-12LC-MM
    - b. Approved Equal.

### 2.08 4-PAIR CATEGORY 6 UNSHIELDED TWISTED PAIR CABLE

- B. Manufacturers: Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:
- 1. Belden Corporation, Carmel, IN (800) 246-2673.
  - 2. Avaya, Basking Ridge, NJ (800) 344-02232.
  - 3. Berk-Tek, Incorporated, New Holland, PA (800) 237-5835.
  - 4. CommScope, Hickory, NC (800) 982-1708.
  - 5. Draka Comteq, Franklin, MA (888) 541-7100.
  - 6. General Cable, Highland Heights, KY (800) 424-5666.

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7. Mohawk/CDT Leominster, MA (978) 537 9961.
8. NORDX/CDT, Worcester, MA (800) 331-0779.
9. Superior Essex, Atlanta, GA. (800) 685-4887.
10. Tyco Electronics, Harrisburg, PA (800) 522-6752.

### B. Conductors: 4 twisted pair - 24 AWG, solid copper w/ RJ-45 connector ends

1. Individually insulated plenum rated conductors under common plenum rated sheath unless entire cable is installed within conduit/EMT or if area where cable is installed is not considered a return air plenum according to any applicable codes.
2. Complies with individual characteristics established in ANSI/TIA/EIA-568-B, and all addendums for Category 6 cable performance specification.
3. Overall Nominal Diameter: .365 x .165 in.
4. Nominal Impedance: 100 ohms plus or minus 15 percent.
5. Certified capable of performing to minimum 350 MHz.

### C. Mechanical Characteristics

1. Operating temperature: -20°C to +80°C
2. Bulk cable weight: 29 lbs./1000 ft.
3. Maximum recommended pulling tension: 45 lbs.
4. Minimum bend radius: 1 in.

### D. Flame test: UL1666 Riser

### E. Electrical Characteristics:

- a. Nom. Mutual Capacitance @ 1 KHz 15.0 pF/ft
- b. Maximum Capacitance Unbalance (pF/100 m) 49.2 pF/100 m
- c. Nominal Velocity of Propagation 70 %
- d. Maximum Delay (ns/100 m) 510 @ 100MHz ns/100 m
- e. Maximum Delay Skew (ns/100m) 25 ns/100 m
- f. Maximum Conductor DC Resistance @ 20 Deg. C 9 Ohms/100 m
- g. Maximum DCR Unbalance @ 20 Deg. C 3 %
- h. Max. Operating Voltage - UL 300 V RMS

## PART 3 - EXECUTION

### 3.01 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 (in writing) 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.

## 16121 - ELECTRIC WIRES AND CABLES

### 3.02 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. Cables shall be installed with maximum slack at all terminal points, boxes, handholes and manholes.

### 3.03 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

### 3.04 600 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 cables after they are installed and

## 16121 - ELECTRIC WIRES AND CABLES

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. 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.

END OF SECTION 16121

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PART 1 – GENERAL

1.01 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 circuits shall be approved by the Contractor before Engineer approval can be given. The Contractor shall submit the approvals from the General Contractor along with the conduit layout submittals for Engineer approval.
- D. 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.
- E. Every conduit shall be tagged to define its system served: power, process/mechanical, instrumentation, telephone, fire alarm, communications and lighting.
- F. 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.

1.02 RELATED SPECIFICATIONS

- A. Specification 09910 - Painting.
- B. Specification 16071 – Supporting Devices.

1.03 PAYMENT

- A. Payment for Electric Conduit System shall be made as provided in Division 1 of the Specifications.

1.04 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.

#### 1.05 SUBMITTALS

- A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer.
- 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.

#### 1.06 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

#### 2.01 PVC COATED RIGID STEEL CONDUIT

- A. The Contractor shall provide PVC coated rigid steel conduit in the locations listed below, unless otherwise noted on drawings, with the exception of where flexible metallic conduit is required to permit movement of connected devices. All steel conduit shall comply with the requirements of ANSI C80.1, and the Underwriters' Laboratories, Incorporated, Standard for No. 6.
  - 1. All exterior above and below grade
  - 2. All Process Areas
- 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.
- 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. PVC coated rigid steel conduit shall be by Perma-Cote Industries, OCAL Incorporated, Robroy Industries or equal to be approved by the Engineer.

## 2.02 RIGID STEEL CONDUIT

- A. The Contractor shall provide rigid steel conduit in the locations listed below, unless noted otherwise on drawings. All steel conduit shall comply with the requirements of ANSI C80.1, and the Underwriters' Laboratories, Incorporated, Standard for No. 6.
  - 1. All interior non-process areas
  - 2. Electrical rooms
- 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. Rigid steel conduit shall be by Allied Tube and Conduit Corporation, Wheatland Tube Company or approved equal.

## 2.03 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 16071 – Supporting Devices. In corrosive locations, concrete inserts shall be 316 stainless steel.
- E. Hangers and supports shall be in accordance with the requirements of Specification 16071 – Supporting Devices 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.

## 2.04 FLEXIBLE METALLIC CONDUIT

- A. The Contractor shall provide flexible metallic conduit only 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.

## 2.05 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 2.06. 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. 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.

## 2.05 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 where PVC conduit is installed, seal fittings shall include interior and exterior coatings equivalent to the PVC conduit coating specified under Article 2.1.
  - 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 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.
  - b. 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.
  - c. 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.
  - d. 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 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.

## 2.06 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 in all areas shall be minimum NEMA Type 4X. Boxes shall be constructed of 316 stainless steel material with sealed seams.
- C. 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.
- 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:

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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

### 3.01 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 09910 - 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.

### 3.02 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 16071 – Supporting Devices. 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.

### 3.03 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.

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- 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.

### 3.04 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 manufacturer's recommendations to provide the additional movement necessary.
- E. All conduit connections shall be made watertight and shall terminate at enclosures with approved conduit hubs.
- F. 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.
- G. All insulated grounding bushings shall be bonded together and to the structure of the enclosure by a continuous, copper bonding wire.
- H. Removable, flame-retardant, insulating cable supports shall be provided in all boxes with any dimension exceeding 3 feet.
- I. 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.



### 3.05 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.

### 3.06 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 3.02 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.

END OF SECTION 16131

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PART 1 - GENERAL

1.01 - SECTION INCLUDES

- A. Conduit.
- B. In general, the conduit system included under this Section shall include, but not be limited to the following:
  - 1. PVC coated rigid hot dipped galvanized steel conduits
- C. Flexible Liquid Tight Metal Conduit
  - 1. Connecting motors and other equipment subject to vibration, maximum length - 3 feet.
  - 2. Passing through building expansion joints.
- D. Conduit fittings: Conduits to be mechanically and electrically continuous from one electrical device to another.
- E. In general, the boxes included under this Section shall include, but not be limited to the following:
  - 1. Outlet, switch, and device boxes
  - 2. Junction boxes (with and without terminals)
  - 3. Pull boxes
  - 4. Refer to the Schedule at the end of this Section for locations of box classes

1.02 - REFERENCES

- A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
- B. ANSI/NFPA 70 - National Electric Code.
- C. NECA Standard of Installation.
- D. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- E. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

- F. NEMA TC 2 – Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
- G. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- H. ANSI/NEMA OS1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
- I. NEMA 250 - Enclosures for Electrical Equipment (1000 volts maximum)

#### 1.03 - SUBMITTALS

- A. Submit product data under provisions of Section 01300.
- B. Manufacturers specifications and other data required demonstrating compliance with the specific requirements.
- C. Materials list showing all items to be furnished and installed under this Section.
- D. Complete shop drawings of all work of this Section showing dimensions and locations of all items including supporting structures and clearance requirements.
- E. Submit two (2) samples of each type conduit, 2 feet in length.
- F. Submit sample of expansion/deflection fitting.

#### 1.04 - REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc.
- B. Conform to requirements of ANSI/NFPA 70.

#### 1.05 - DELIVERY, STORAGE AND HANDLING

- A. Deliver and store all products in accordance with the manufacturers recommendation, as approved by the Engineer, with all labels and seals intact and legible.
- B. Provide off-site storage and protection when site does not permit on-site storage or protection.
- C. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- D. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

- E. In case of damage to a product during transportation, handling or storage, the Contractor shall immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.
- F. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- G. Each length of conduit shall be shipped with one coupling on one end, a threaded protector at the other end.

#### 1.06 - PROJECT CONDITIONS

- A. Verify all conduit routings by field measurements.
- B. Verify routing and termination locations of conduit prior to rough-in.
- C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system. Provide all required sweeps, boxes, and fittings.

### PART 2 - PRODUCTS

#### 2.01 – PVC COATED STEEL CONDUIT

- A. 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. The conduit shall be coated on the interior and exterior.
- B. Conduits, elbows and couplings shall include a PVC coating for all areas.
- C. PVC coated rigid steel conduit shall be by Perma-Cote Industries, OCAL Incorporated, Robroy Industries or equal to be approved by the Engineer.

#### 2.02 – HAZARDOUS LOCATION FITTINGS CLASS I, DIV. I

- A. Conduit Unions: Class 1, Div. 1 Types UNF and UNY as manufactured by O-Z/Gedney or approved equal.
- B. Sealing Fittings: Class 1, Div. 1 types EYA and EYAM as manufactured by O-Z or approved equal.

- C. Sealing Hub: Class 1, Div. 1 type EYHSG with Sealing Gasket and Locknut as manufactured by O-Z/Gedney or approved equal.
- D. Explosion proof sealing compound systems for fittings and hubs shall consist of a fiber material (to form a dam for the sealing material) and the sealing compound itself. Both the fiber and sealing compound shall be rated for use in the classified area and shall be compatible with the fitting or hub being sealed.
  - 1. Manufacturers and their particular products shall be as follows:
    - a. Appleton Electric Co., "Kwiko Sealing Cement & Fiber Filler"
    - b. Crouse-Hinds, "Chico A Sealing Compound & Chico X Fiber"
    - c. O-Z/Gedney, "Type EYC and Type EYF"
- E. Conduit Fittings:
  - 1. Conduit fittings shall be furnished and installed as required and shall include unions, threaded hubs, nipples, enlargers, reducers, couplings, locknuts, bushings, etc. All fittings shall be steel with zinc electroplate finish or malleable iron with zinc electroplate finish. All fittings shall have insulated throats (where applicable).
  - 2. Conduit fittings shall be manufactured by the following: Appleton Electric Company, Crouse-Hinds, O-Z/Gedney
- F. Expansion couplings for use in conduit runs shall be the expansion/deflection type. Expansion couplings shall have iron or bronze ends, neoprene sleeves, stainless steel bands and tinned flexible copper braid bonding jumper. Couplings shall be watertight, corrosion resistant and concrete tight.
  - 1. Manufacturers and their particular products shall be as follows: Appleton Electric Company; "Type DF", Crouse-Hinds; "Type XD", O-Z/Gedney; "Type DX".
  - 2. For explosive areas, expansion unions shall be utilized. Expansion unions shall be steel with zinc electroplate finish and have copper or bronze grounding spring or jumper.
    - a. Manufacturers and their particular products shall be as follows:
      - 1) Appleton Electric Company; "Type UN"
      - 2) Crouse-Hinds; "Type UN"

3) O-Z/Gedney; "Type UN"

- G. Grounding Bushings: Grounding bushings shall be insulated, shall be constructed of malleable iron or steel with zinc plated finish, and shall have a tin plated copper saddle. Insulating material shall have a 150° rating. Grounding bushing shall be O-Z/Gedney, "Type BLG", or approved equal.
- H. Liquid-tight Fittings: Liquid-tight fittings shall be furnished and installed wherever liquid-tight conduit is used. Liquid-tight fittings shall be constructed of steel or malleable iron. Fittings shall be zinc coated. Fittings shall be liquid, rain and oil tight. Sealing rings shall be neoprene. All throats shall be insulated. Liquid-tight fittings shall be Appleton Electric Company, "Type ST"; O-Z/Gedney "Type 4Q", or approved equal.
- I. Explosion-Proof Fittings: Explosion-proof fittings shall be constructed as described above except fittings shall be listed for use in classified areas.
  - 1. Manufacturers and their particular products shall be as follows:
    - a. Appleton Electric Co., "Types BR, EC, EL, ES, EX, EY, and PLG"
    - b. Crouse-Hinds, "Types EC, EL, ES, EY, PLG and RE"
    - c. O-Z/Gedney, "Types EC, EL, EY, PLG, RB and RE"
    - d. The above products are meant as a guide and products from the above manufacturers not specifically mentioned do not exclude their use, if they comply with these specifications.
- J. PVC Coated Fittings: PVC coated fittings shall be as described in the paragraphs above except the fittings shall be PVC coated.
- K. Conductive Compound: Conductive compound shall be a grease metallic type and shall be Thomas & Betts, "KOPR-SHIELD", or equal.
- L. Conduit Bodies:
  - 1. Conduit bodies shall be cast type with threaded hubs and shall be made of copper-free aluminum or malleable iron. Copper-free aluminum bodies shall have an aluminum enamel finish. Malleable iron bodies shall have a zinc electroplate and aluminum enamel finish. Finishes shall be applied after all machining has been completed.
  - 2. Conduit body covers shall be of the same material and finish as the conduit body. All

screws shall be stainless steel. All covers shall come with rubber or neoprene gaskets.

3. Manufacturers and their particular products shall be as follows:

- a. Appleton Electric Company; "Form 35 and Form 85"
- b. Crouse-Hinds; "Mark 9"
- c. O-Z/Gedney; "Malleable iron/copper-free aluminum conduit bodies"

M. Mogul Conduit Bodies:

- 1. All conduit bodies 2" and larger and where physically necessary, shall be of the "mogul" type. Mogul type conduit bodies shall conform to the specifications above as to materials, finish, covers, etc.
- 2. Manufacturers and their particular products shall be as follows:
  - a. Appleton Electric Company; "Mogul Unilets"
  - b. Crouse-Hinds; "Mogul Conduit Outlet Bodies"

N. Explosion-Proof Conduit Bodies:

- 1. Explosion-proof conduit bodies shall be constructed as indicated, except the conduit bodies shall be listed for use in the particular classified area.
- 2. Manufacturers and their particular products shall be as follows:
  - a. Appleton Electric Company; "CPU, ELB, ER, GU and GR Series"
  - b. Crouse-Hinds; "CPS, EAB, GU and OE Series"
  - c. O-Z/Gedney; "GU and LBH Series"
  - d. The above products are meant as a guide and products from the above manufacturers not specifically mentioned do not exclude their use, if they comply with these specifications.

O. Explosion Proof Flex:



2.03 - FLEXIBLE LIQUID-TIGHT METAL CONDUITS AND FITTINGS

- A. Liquid-tight flexible metal conduit shall be ANACONDA or approved equal.
- B. Description: Interlocked steel construction with PVC jacket.
- C. Provide flexible liquid-tight conduits and fittings as manufactured by THOMAS & BETTS CORP., O.Z. GEDNEY CO. or approved equal. Catalog numbers used below are those of the THOMAS & BETTS CORP., based on 3/4" size and are to be considered as standards by which equivalents are to be judged. All conduit shall be liquid-tight flexible type, UL type UA, or suitable for exposure to continuous or intermittent moisture.
- D. Flexible liquid-tight connectors shall be Series 5333 or equal.
- E. For all non-hazardous areas, indoor and outdoor, flexible liquid tight metal conduits shall be used.
- F. For hazardous areas flexible conduit shall explosion proof rated and include a brass inner core with a bronze outer braid and protective neoprene plastic coating. End fittings shall be steel, brass or bronze.

2.04 - BOXES

- A. General Purpose:
  - 1. General purpose outlet, switch and device boxes shall be constructed of stamped sheet steel. Minimum box size shall be 4" x 4" x 2-1/8".
  - 2. Box sizes shall have standard industry and manufacturer dimensions. Gangable boxes are not allowed. Conduit knockouts are allowed on these boxes.
  - 3. Box covers, partitions, screws, etc. shall be of the same material as the box, and shall be furnished and installed as required for a complete installation.
  - 4. General purpose outlet, switch and device boxes shall be as manufactured by: Appleton Electric Company, Raco, Steel City, or approved equal
  - 5. Masonry boxes shall be as in paragraph 2.01 (A) (1) but shall be constructed specifically for installation in masonry block or tile walls.
- B. Cast Boxes (Non-Explosion Proof):
  - 1. Cast outlet, switch and device boxes shall be constructed of copper-free aluminum or malleable iron, shall have an epoxy powder or zinc electroplate with aluminum enamel

coat finish, threaded hubs and integral mounting lugs.

- a. Covers shall be malleable iron or aluminum. Screws shall be stainless steel. Neoprene or rubber gaskets shall be provided for all boxes.
2. PVC coated cast outlet, switch and device boxes shall be constructed as in 1. above except boxes and covers shall be PVC coated.
  - a. Cast box manufacturers and their particular products shall be as follows:
    - 1) Appleton Electric Company, "Type FS & FD"
    - 2) Crouse-Hinds, "Type FS & FD"
    - 3) O-Z/Gedney, "Type FS & FD"
    - 4) Or approved equal
3. Covers for cast boxes shall mate with the device installed as required and shall match the environment, that is, PVC coated, non-corrosive, weatherproof, etc.
  - a. Cover manufacturers and their particular products shall be as follows:
    - 1) Appleton Electric Company, "Type FSK"
    - 2) Crouse-Hinds, "Type DS, S and WLR"
    - 3) O-Z/Gedney, "Type FS-1 and FS-2"
    - 4) Or approved equal
4. Above model types do not exclude cover types not shown, but in general will be the types used in the majority of applications. Special applications may require covers not shown above.

C. Explosion Proof Boxes:

1. Explosion proof outlet, switch, and device boxes shall be cast type with threaded hubs. Bodies and covers shall be iron with zinc electroplate finish or copper-free aluminum with epoxy powder coat finish. Screws shall be stainless steel. Boxes shall be PVC coated where required.
2. Boxes, covers and devices in explosion proof areas are many times provided by

manufacturers as a complete unit in either factory sealed or non-sealed models. The quantity and type required shall be as shown on the Contract Drawings and as needed for a complete installation.

3. The switches, receptacles and devices mounted within these boxes shall be as specified in other sections of this Specification.
4. The box/cover/device manufacturers shall be as follows:
  - a. Appleton Electric Co.; "EDS, EFS, EPS and GUSC Series"
  - b. Crouse-Hinds; "EDS, EFD, EFS, FSPC and GUSC Series"
  - c. O-Z/Gedney; "EFS and EFD Series"

## 2.05 - JUNCTION AND PULL BOXES

### A. General Purpose:

1. General-purpose junction and pull boxes shall be constructed of stamped sheet steel. Minimum box size shall be 4" x 4" x 2-1/8". Box sizes shall have standard industry and manufacturer dimensions. Gangable boxes are not allowed. Conduit knockouts are allowed on these boxes.
  - a. Box covers, partitions, screws, etc. shall be of the same material as the box and shall be furnished and installed as required for a complete installation.
  - b. General purpose junction, pull and terminal boxes shall be as manufactured by: Appleton Electric Company, Raco, Steel City, or equal.
2. Masonry boxes shall be as specified above, but shall be constructed specifically for installation in masonry block walls.

### B. NEMA 1 Boxes:

1. NEMA 1 boxes shall be used when stamped steel boxes are not available in the sizes required. NEMA 1 boxes shall be sized as shown on the Contract Drawings or, if not specifically dimensioned, as required per NEC requirements.
2. Boxes shall be constructed of steel without conduit knockouts. Boxes shall be constructed as follows:

Maximum Dimension	USS Gauge
Up to 24 inches	No. 16
Greater than 24 up to 36 inches	No. 14
Greater than 36 inches	No. 12

3. Box covers with weights of 10 pounds or greater shall have two (2) handles welded to the cover. Boxes may also be furnished with a door instead of a cover. If provided with a door, box door shall open 180° and shall have quarter turn or flush handle latches.
4. Box covers, doors, screws, partitions, etc., shall be of the same material as the box and shall be furnished and installed as required for a complete installation.
5. Boxes shall have ANSI 61 gray polyester powder finish inside and out.

C. NEMA 12 Boxes:

1. NEMA 12 boxes shall be sized as shown on the Contract Drawings or, if not specifically dimensioned, as required per NEC requirements.
2. Boxes shall be constructed of steel without conduit knockouts and shall be gasketed.
3. Boxes shall be constructed as follows:

Maximum Dimension	USS Gauge
Up to 24 inches	No. 16
Greater than 24 up to 36 inches	No. 14
Greater than 36 inches	No. 12

4. Box covers with weights of 10 pounds or greater shall have two (2) handles welded to the cover. Boxes may also be furnished with a door instead of a cover. If provided with a door, box door shall open 180° and shall have door clamps. Door shall be continuously hinged.
5. Boxes shall have ANSI 61 gray polyester powder finish inside and out.

D. NEMA 4 Boxes:

1. Cast junction and pull boxes shall be malleable iron or copper free aluminum with threaded hubs and integral mounting lugs. Copper-free aluminum boxes shall have an aluminum enamel finish. Malleable iron boxes shall have a zinc electroplate and

aluminum enamel finish or epoxy powder coat. Finishes shall be applied after all machining.

- a. Covers shall be of the same material and finish as the box. All screws shall be stainless steel. All covers shall come with rubber or neoprene gasket. PVC coated boxes and covers shall be provided where required.
  - b. Manufacturers and their particular products shall be as follows:
    - 1) Appleton Electric Co.; "GS, JB and SEH Series"
    - 2) Crouse-Hinds; "ARB, GRF, GS, VGR and VXF Series"
  - c. It is the intention of these specifications to limit the use of cast junction and pull boxes to the types listed above. These types of boxes are generally used for lighting, receptacle, fire alarms, etc. type of circuits which usually have a conduit size of 1" or smaller. Where larger size pull or junction boxes are required in NEMA 4 areas, boxes as described below shall be used.
2. Non-Cast type NEMA 4 junction and pull boxes shall be sized as shown on the Contract Drawings or, if not specifically dimensioned, as required for NEC requirements.
- a. Boxes shall be constructed of steel without conduit knockouts and shall be gasketed. Boxes shall be continuously welded.
  - b. Boxes shall have doors which open 180°, have stainless steel clamps and stainless-steel continuous hinge.

E. NEMA 4X Boxes:

1. 304 Stainless Steel-
  - a. NEMA 4X junction and pull boxes shall be constructed of 304 stainless steel.
  - b. Boxes shall be continuously welded with no holes or knockouts. Boxes shall have seamless foam-in-place gasket, body stiffeners where required, stainless steel door clamps and continuous hinge.
  - c. Box doors and all exterior hardware shall be 304 stainless steel.
  - d. Boxes shall be unpainted. Boxes shall have smooth brushed finish.

F. Explosion Proof Boxes:

1. Explosion proof junction and pull boxes shall be constructed of cast iron or cast aluminum with covers or doors of same material. Screws and bolts shall be stainless steel. Boxes shall be PVC coated where required.
  - a. Boxes shall be rated for use in the hazardous area it is to be installed in
  - b. Boxes shall be sized as shown on the Contract Drawings or, if not specifically dimensioned, as required per NEC requirements.
  - c. Boxes, covers and doors shall have a polymer enamel finish.
2. PVC coated cast explosion proof boxes shall be as specified above except boxes, covers and doors shall be PVC coated. All boxes shall contain a neoprene gasket.
  - a. Cast explosion proof box manufacturers shall be as follows:
    - 1) Appleton Electric Co.; "DER, EJB, EXB, GUB and JBE Series"
    - 2) Crouse-Hinds; "DHE, EJB, EJH, and GU Series"
    - 3) O-Z Gedney; "IG, OFB and YG Series"

G. Terminal Boxes:

1. Terminal boxes shall be identical to junction and pull boxes specified above for the following: NEMA 1 Boxes, NEMA 12 Boxes, NEMA 4 Boxes, NEMA 4X Boxes, Explosion Proof Boxes, or approved equal
2. In addition to the above description, each terminal box shall have a steel panel with terminal blocks installed on mounting studs within the box.
3. The steel panel shall be painted with white enamel and shall be at least one USS gauge size thicker than the box thickness.
4. The terminal blocks shall be screw type, rated 600V, 20A minimum. Terminal blocks shall be phenolic, accept up to a #10 AWG wire and have a marking strip.

2.08 - WIRE TROUGH

- A. Wire trough shall be manufactured by SQUARE D or equal.

- B. Wire trough shall be completely enclosed with removable sealed front cover.
- C. Construction: Less than 8-inch square shall not be used. All wire troughs shall be 14-gauge.
- D. Finish: ANSI-49 epoxy paint applied by cathodic electro-deposition paint process over a corrosion resistant phosphate preparation or stainless steel, as indicated in the schedule.

## 2.09 – ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT THREAD COMPOUND

- A. KOPR-SHIELD or approved equal.

## PART 3 - EXECUTION

### 3.01 – INSTALLATION OF CONDUITS

- A. Except as shown on the Contract Drawings, the minimum size conduit permitted is  $\frac{3}{4}$  inch.
  - 1. Each length of conduit installed shall be free from blisters and other defects. Each piece installed shall be cut square, taper reamed, and a coat of sealing compound applied to threads. Threads on conduits shall be painted with a conducting compound prior to assembly. Conduit connections shall be screwed tight with only incomplete threads exposed. All conduit joints shall be made with standard couplings and the ends of the conduit shall butt tightly into the couplings. In exposed work only, where standard couplings cannot be used, only Erickson couplings are permitted, or as otherwise acceptable to the Engineer.
  - 2. Conduit threaded in the field shall have standard sizes and lengths. Conduit joints shall be cut square, threaded, reamed smooth, and drawn up tight so conduit ends will butt in couplings, connectors, and fittings.
  - 3. Secure conduits to all boxes and cabinets with double locknuts and bushings so system will be electrically continuous from service to all outlets.
  - 4. Install conduit in accordance with NECA Standard of Installation.
  - 5. Cap ends of conduits to prevent entrance of water and other foreign material during construction.
  - 6. Complete all conduit systems before pulling conductors.
  - 7. Minimum conduit depth shall be 18" below grade, measured to the top of the conduit on exterior underground installations.

- B. Support conduits under provisions of Section 16070, unless specifically described herein.
  - 1. Provide cable supports in conduits rising vertically in accordance with the National Electric Code.
  - 2. Provide No. 12 AWG copper pull wires or 250-lb tested polyethylene line in all empty conduits. Steel wire not acceptable as pull wire. Provide two foot slack at each end.
  - 3. Install conduit to preserve fire resistance rating of partitions and other elements.
- C. Ground and bond conduit under provisions of Section 16060.
- D. Where neither length of conduit can be rotated, ERICKSON couplings Series 676 shall be used.
- E. Provide steel, or malleable iron nylon insulated bullet hub, Series 370-379, complete with recessed sealing "O" ring, in areas:
  - 1. Where enclosed and gasketed fixtures and weatherproof devices are specified;
  - 2. Where rigid conduit enters a sheet metal enclosure, junction box and outlet box, and not terminated in a threaded hub.
  - 3. Do not use die cast material.
- F. Where exposed conduits running overhead pass through building expansion joints, install flexible liquid tight conduit of same size with sufficient slack to allow conduits on either side of expansion joint to move a minimum of 3-inches in any direction. Provide supports as required on each side of expansion joint, all in accordance with seismic requirements of specific area.
  - 1. Failure to route conduit through building without interfering with other equipment and construction shall not constitute a reason for an extra charge. Equipment, conduit and fixtures shall fit into available spaces in building and shall not be introduced into building at such times and manner as to cause damage to structure. Equipment requiring servicing shall be readily accessible.
  - 2. Factory bent elbows or field bent elbows with approved tools may be used. Heating of conduit to facilitate bending is prohibited.
  - 3. Install exposed conduit either parallel or perpendicular to structural members, unless impractical. Group conduit wherever possible. Conduit shall be attached to structural components with approved supports spaced a maximum of six (6) feet apart and shall form a neat rigid installation. Conduit supported from building walls shall be installed with



at least  $\frac{1}{4}$ -inch clearance from the walls to prevent the accumulation of dirt and moisture behind the conduit.

- G. Conduit and/or conduit fittings shall not be welded together or to any steel structure; however, conduit supports may be welded to flanges of steel beams and columns in accordance with approved welding techniques and engineering practice in locations acceptable to the Owner.
- H. All conduits extending through the floor behind panels or into control centers or similar equipment shall extend a minimum of 6 inches above the floor elevations, with no couplings at floor elevation.
- I. All exposed conduits rising above finished floor elevation, excluding those encompassed by an equipment pad, shall be provided with a 4-inch high curb. Three (3) inches of cover shall be provided horizontally around the conduit.
  - 1. Conduit installed in concrete or masonry walls shall be so arranged that a minimum of 3-inches of covering be obtained. Spacings between conduits shall be sufficient to permit a complete filling with concrete or mortar without voids.
  - 2. Install conduit runs in such location as to avoid steam or hot water pipes. Provide a minimum separation of 12 inches where conduit crosses or parallels hot water or steam pipes.
- J. Install conduits containing instrumentation cable to provide the following clearances: Conduits installed parallel to conductors energized at 480 volts shall have a clearance of 18 inches and 208/120 volts shall have a clearance of 12 inches.
- K. Conduits installed at right angles to conductors energized at 480 Volts or 120/208 Volts shall have a clearance of six (6) inches.
- L. Where practicable, conduits containing instrumentation cable shall cross raceway-containing conductors of other systems at right angles.
- M. The cutting of walls or floors for conduit shall be kept to a minimum. Where such cutting is necessary, care shall be taken so as not to weaken the walls or floor involved. Beams or other structural supports shall not be cut under any condition.
- N. Protect conduit 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 and pull wire and cable. Before wire or cable is pulled, insulated bushings shall be installed at each end of the conduit.

- O. Conduit installation shall be arranged to minimize cleaning. No horizontal runs of conduit will be permitted on brick or masonry walls.
- P. When installing PVC coated rigid galvanized steel conduit use only a vise approved for PVC coated conduit. The use of a chain vise will not be permitted. Where PVC coated rigid galvanized steel conduit and fittings are specified, PVC coating damaged during transportation, loading, installation, etc. or cut during threading shall be repaired with the same type of covering obtained from and in accordance with the manufacturers recommendations.
- Q. Connections from rigid conduit to motors, limit switches, solenoid valves, level controls, etc. and all devices subject to vibration shall be made with short lengths of flexible metal conduit. These lengths shall be provided with appropriate connectors with devices that will provide an excellent electrical connection between equipment and the rigid conduit for the flow of ground current.
- R. Conduit Bodies and Fittings:
  - 1. Install conduit bodies and fittings as necessary and where required, to complete the electrical conduit system. Conduit bodies and fittings shall also be installed wherever a pull point is necessary to keep the number of 90° bends in a conduit run to the maximum specified previously.
  - 2. Paint the threads of all conduit bodies and fittings with a conductive compound prior to assembly.
  - 3. Where all-thread nipples are used between fittings and electrical equipment, install nipples such that no threads are exposed.
  - 4. All conduit bodies and fittings shall be compatible in the environment installed.
  - 5. Seal fittings in explosion-proof areas where required in accordance with the NEC.
  - 6. The use of two (2) locknuts and a grounding bushing will be required at all conduit terminations where hub type fittings are not required.
  - 7. Provide weatherproof insulated throat Meyers hubs on all conduit entries to boxes and devices without integral hubs.
- S. Expansion Fittings: Install Expansion fittings in conduit runs wherever conduit crosses structural expansion joints, wherever conduits are attached between the two (2) separate structures, and wherever a conduit run is 100 feet or more in a single straight length.
- T. Grounding Bushings: Install grounding bushings wherever conduits enter equipment or

enclosures without integral hubs. All grounding bushings within an enclosure or piece of equipment shall be bonded together with a ground cable.

- U. Support conduit using lay-in adjustable hangers, clevis hangers, and split hangers.
  - 1. Group related conduits and support using conduit rack. Provide space on each rack for 25 percent additional conduits.
  - 2. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
  - 3. Do not attach conduit to ceiling support wires.
  - 4. Arrange conduit to maintain headroom and present neat appearance.
  - 5. Avoid moisture traps; provide junction box with drain fitting or breather at low points in conduit system.
- V. Conduits for submersible pump seal leak and motor overtemperature control wires shall be installed in separate conduits than the power conductors for the pump.
- W. Accurately record actual routing of all conduits.
- X. Do not use dissimilar strap or clamp support. Provide dielectric tape, fittings, straps, and bushings where dissimilar metals are used.
- Y. Where fittings for liquid-tight flexible conduit are brought into an enclosure with a knockout, a gasket assembly, consisting of one piece "O" ring, with a BUNA-R sealing material, Series 5200, shall be installed on outside of box. Fittings shall be made of either steel or malleable iron only, and shall have insulated throats or insulated bushings.
- Z. A copper ground wire sized in accordance with NEC shall be installed on the inside of the conduit as a jumper around flexible conduit to assure a continuity of ground.
- AA. Install a copper jumper across all flexible conduit including motors, fixtures, controls and other utilization equipment.
- BB. Install liquid-tight flexible conduit in such a manner as to prevent liquids from running on surface toward fittings.
- CC. Allow sufficient slack conduit to reduce the effect of vibration.

- DD. Complete all conduit systems before pulling the conductors.
- EE. Support in accordance with requirements of National Electric Code.
- FF. All threaded conduits and fittings shall have KOPR-SHIELD compound applied to all threads prior to assembly.

### 3.02 – INSTALLATION OF BOXES

#### A. General:

1. Mount all boxes rigidly and securely to the building structure or to supporting devices, which are rigidly and securely supported to the building structure. Boxes shall not be supported from suspended ceiling systems.
2. All boxes and supports, regardless of the location, shall be fastened with 304 stainless steel bolts and expansion shields on concrete or brick, with 304 stainless steel toggle bolts on hollow masonry units, and with stainless steel machine screws or welded studs on steelwork.
3. Mount boxes with sides parallel or perpendicular to walls or equipment, such that the box is installed in a neat and professional manner.
4. Install all boxes such that wiring within are accessible.
5. Install blanking devices or threaded plugs in all unused holes.
6. Install all boxes concealed in finished walls when possible.
7. Set boxes so that front edges are flush with finished surfaces

#### B. Locations and Sizes:

1. Box locations shown on the Contract Drawings are approximate. Box sizes shall be as dimensioned on the Contract Drawings, or, if not specifically dimensioned, as required by the NEC. Additional boxes required but not specifically shown shall be furnished and installed under this Contract.
2. The equivalent number of 90 degree bends in a single conduit run is limited to the following:

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- a. Runs in excess of 300 feet: 0
  - b. Runs of 300 feet to 201 feet : 1
  - c. Runs of 200 feet to 101 feet : 2
  - d. Runs of 100 feet and less: 3
- 3. Boxes shall be furnished and installed wherever necessary to satisfy the above criteria.
  - 4. Review all box sizes and locations with the Engineer prior to installation.
- C. Grounding:
- 1. All boxes shall be grounded in accordance with NEC requirements.
  - 2. The use of two (2) locknuts and a grounding bushing will be required at all conduit terminations where hub type fittings are not required. Conduit grounding bushings within boxes shall be bonded together with jumper cables where box size or number of conduits warrants their use per NEC requirements.
- D. Terminal Boxes: In addition to all box requirements described above, terminal boxes shall have terminal blocks for boxes that contain control or signal wires which must be interconnected. Approximately 20 percent space terminals shall be provided (minimum of two [2]). Terminals shall be lettered or numbered to conform to the wiring diagrams.

### SCHEDULE 16132-1 BOX & TROUGH SCHEDULE

- A. Box Classification For Cedar Creek Wastewater Treatment Plant:
- 1. General Purpose: Masonry walls.
  - 2. Cast: Masonry walls.
  - 3. NEMA 1: The following areas fall under this classification: MCC Rooms in North RAS Building and MCC Rooms in South RAS Building, unless otherwise indicated on the plans.
  - 4. NEMA 12: Not used.
  - 5. NEMA 4: Not used.
  - 6. NEMA 4X Stainless Steel: Used in areas subject to weather, sunlight, humidity, moisture,

## 16132 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

or other areas defined by the Engineer. The following areas fall under this classification: All other interior and exterior locations, not specifically specified elsewhere in this paragraph.

7. NEMA 4X Fiberglass: Not Used.
  8. PVC Coated Boxes: Where PVC is preferred over stainless steel by the Engineer.
  9. NEMA 6P: Hazardous Areas, Class 1 Div. 1
- B. Identification: All pull boxes, junction boxes, and terminal boxes shall have a nameplate attached, which properly identifies the box. Nameplates shall be installed as specified in Section 16075 – Electrical Identification.

END OF SECTION 16132

## 16133 - UNDERGROUND DUCTS – DUCTS IN CONCRETE

### PART 1 - GENERAL

#### 1.01 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.

#### 1.02 RELATED SPECIFICATIONS

- A. Specification 02200 – Earthwork
- B. Specification 03300 - Cast-in-Place Concrete
- C. Specification 16061 - Grounding
- D. Specification 16131 - Electric Conduit System

#### 1.03 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.

#### 1.04 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

## 16133 - UNDERGROUND DUCTS – DUCTS IN CONCRETE

banks dimensionally from fixed objects or structures. Include profiles of duct banks showing crossings with piping and other underground systems.

### 1.06 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

### 2.01 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.

### 2.02 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.

### 2.03 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.

### 2.04 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.

### 2.05 DUCT SEAL

- A. Duct seal for conduits shall be in accordance with the requirements of Specification 16131 - Electric Conduit System.

### 2.06 REINFORCED CONCRETE

- A. Concrete for envelope shall be Class 40 concrete in accordance with the requirements of Specification 03300 - Cast-in-Place Concrete.



## 16133 - UNDERGROUND DUCTS – DUCTS IN CONCRETE

### 2.07 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.

### 2.08 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

### 3.01 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.

## 16133 - UNDERGROUND DUCTS – DUCTS IN CONCRETE

- 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 02200 - Earthwork. 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 16133

## SECTION 16140 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.01 SECTION INCLUDES

- A. Provide all labor, equipment and material necessary to furnish, install and test wiring devices, complete, in place, as shown on the Contract Drawings, specified herein and approved by the Engineer.
- B. In general, the wiring devices included under this Section shall include, but not be limited to receptacles and lighting switches.

#### 1.02 REFERENCES

- A. ANSI/NFPA 70 - National Electric Code.
- B. NEMA WD1 - General Purpose Wiring Devices.

#### 1.03 SUBMITTALS

- A. Submit product data under provisions of Section 01300.
- B. Provide manufacturer's catalog information showing dimensions, colors and configuration.

### PART 2 - PRODUCTS

#### 2.01 SWITCHES

- A. Due to the large number of possible combinations of devices available, only the most frequently used devices are detailed in the following sections. Where devices are required which are not specified here, the device shall be specified on the Contract Drawings.
- B. Devices shall be furnished with all necessary auxiliary items, as required, for a proper installation and operation such as screws, gaskets, protective boots, explosion proof seals, etc.

#### 2.02 RECEPTACLES – GENERAL PURPOSE

- A. Receptacles shall be heavy duty, specification grade, duplex type, 125V, 20A, NEMA WD-1, 2 poles and 3 wires grounding type, unless shown otherwise on the Contract Drawings.
- B. Receptacles shall be back and side wired, have a green ground screw terminal, automatic ground clip, fully enclosed in composition case and nylon face. Receptacles shall also have a wrap around bridge with integral ground contacts and heat resistant base for dimensional stability.

## SECTION 16140 - WIRING DEVICES

- C. Receptacles shall be brown unless shown otherwise on the Contract Drawings. Where brown receptacles are not available for a particular type, receive Engineer's approval for alternate color.
- D. All receptacles shall be corrosion resistant, have an isolated ground, and ground fault interrupter.
- E. The receptacles shall be equal to Hubbell, "5362 Series", or approved equal.
- F. Receptacles for winches shall be equal to Hubbell "9530 Series" 30A, 250V.
- G. Specialty receptacles that have either high amperage or voltage rating, or other configuration, shall be as identified on the Contract Drawings.

### 2.03 SWITCHES

- A. Switches shall be heavy duty, specification grade, toggle type, 120/277V, NEMA WD-1, 20A, single pole, unless shown otherwise on the Contract Drawings.
- B. Switches shall be back and side wired, fully enclosed in composition case and shall have rivetless spring contact arm to eliminate stress and weak points. Contacts shall be silver cadmium oxide to eliminate welding. Switches shall have a #8 brass, green ground screw and stainless steel automatic grounding clip.
- C. Switches shall be brown unless shown otherwise on the Contract Drawings. Where brown switches are not available for a particular type, receive Engineer approval for alternate color.
- D. Where indicated on the Contract Drawings, provide switches that are double pole, 3-way, 4-way, key operated, illuminated, etc.
- E. The switches shall be equal to Hubbell, "HBL 1220 Series".
- F. Where 15A and 30A switches are shown, they shall be equal to Hubbell, "HBL 1200 Series" and Hubbell, "HBL 3030 Series".
- G. Specialty switches with other configurations shall be as identified on the Contract Drawings.
- H. Switches - Explosion Proof:
  - 1. Switches shall be 125V, 20A, 120/277V, single pole unless shown otherwise on the Contract Drawings.
  - 2. Switches shall be installed in an aluminum-sealing chamber (when factory sealed) and shall have a malleable iron cover with a front operated handle. The handle shall be

## SECTION 16140 - WIRING DEVICES

lockable in either the "on" or "off" position. The cover shall be compatible with the back box finish, such as epoxy powder coated, as specified in Section 16132.

3. The switch housing shall mount onto an appropriate black box with four (4) stainless steel screws.
4. Where indicated on the Contract Drawings, provide switches that are 2-pole, 3-way or 4-way.
5. The switches shall be equal to Appleton Electric Co., "Types EDS and EFS".

### I. Switches – Weatherproof Cover:

1. NEMA Rating: 3R
2. Mounting Hardware: Stainless Steel
3. Device Type: Toggle Switch
4. Construction: Metal
5. The switches shall be equal to Leviton, "Types WM1S"

## 2.04 DEVICE PLATES - FLUSH MOUNTED

- A. Device plates for flush mounted devices shall be smooth metal, 302 stainless steel type. Edges shall be contoured with satin finish. Device plates shall be 0.040 inches thick. Screws shall be stainless steel.
- B. Device plate manufacturers and their particular products shall be as follows: General Electric, "93000 Series", Hubbell, "97000 Series".
- C. Device plates for surface mounted devices shall be sheet steel, aluminum, or malleable iron for non-corrosive/weatherproof devices, and shall be die cast aluminum or malleable iron, with gasketed covers for corrosive/weatherproof devices.
- D. All screws shall be stainless steel.
- E. Corrosive/weatherproof device plates shall match the finish of the device box, such as epoxy powder coated, etc., as specified in Section 16132.
- F. The device plates shall be as manufactured by the following: Appleton Electric Co., "Type FSK", Crouse-Hinds, "Types DS and WLR".

## SECTION 16140 - WIRING DEVICES

- G. Device plates for explosion proof devices are an integral part of the device. The device plate shall be as described in the explosion-proof receptacle and switch paragraphs above.

### 2.05 MANUAL MOTOR RATED THERMAL SWITCH

- A. Acceptable Manufacturers: SQUARE D, Class 2510, Type KW1A, Type KW1B, Type KW2B (3-pole, 277V), Type KW2C (3-pole, 600V), or approved equal.
- B. Contractor shall coordinate voltage, phase and current rating with equipment.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. All wiring device locations are approximate. Determine the proper location of wiring devices based on field conditions and equipment requirements. Review wiring device locations with Engineer.
- B. General-purpose receptacles shall be mounted 1'-6" above finished floors (to centerline of receptacle) unless shown otherwise.
- C. Lighting switches shall be mounted 4'-6" above finished floor (to centerline of switch) unless shown otherwise.
- D. Receptacles and switches shall be mounted at different heights, where necessary, due to field conditions or where required by specific equipment (such as a kitchen stove, water cooler, etc.).
- E. Polarity: Properly wire all receptacles so that the hot wire, the neutral wire and the ground wire connect to the proper terminal on all receptacles.
- F. Grounding: Install all receptacles in boxes specified under Section 16060 and install a No. 12 green ground wire from device grounding terminal to the outlet box in accordance with the National Electric Code.

### 3.02 BOXES

- A. Boxes used for the wiring devices shall conform to the requirements of Section 16132.

### 3.03 CIRCUITING

- A. Wiring devices shall be circuited as shown on the Contract Drawings and shall comply with the requirements of the NEC.

## SECTION 16140 - WIRING DEVICES

- B. All receptacles shall be pigtailed to the supply circuit with #12 AWG wires. Pigtails shall be stranded copper. Pigtail wire colors shall match supply circuit colors. Connection to the supply circuit shall be with properly sized wire nuts.

### 3.04 DEVICE PLATES

- A. Device plates shall be installed wherever a wiring device is installed. All device plates shall be set true and plumb and shall fit tightly against the finished wall surfaces and device boxes.
- B. Where multiple devices are mounted in a box, gang plates shall be used. Gang plates shall be one (1) piece. Assembled gang plates shall not be allowed.
- C. Where plugs are being furnished with receptacles, connect the plugs to the flexible cords of equipment as directed by the Engineer. Provide all necessary devices for proper connection of plug to flexible cord.

### 3.05 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects. Operate each wall switch with circuit energized and verify proper operation. Verify that each receptacle device is energized. Test each receptacle device for proper polarity. Test each GFCI receptacle device for proper operation.

+ + END OF SECTION + +

SECTION 16140 - WIRING DEVICES

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## VARIABLE FREQUENCY DRIVE (VFD)

### PART 1 – GENERAL

#### 1.1 General

- A. This specification defines the minimum requirements for Variable Frequency Drives (VFD) and accessories for speed control of either constant or variable torque loads.

#### 1.2 Related Work: None.

#### 1.3 References:

- A. UL 508C
- B. CE
- C. NEC
- D. Canadian Underwrites Laboratory (cUL)
- E. ISO 9001
- F. IEEE519-2014

### PART 2 – PRODUCTS

#### 2.1 Acceptable Manufacturers:

- A. Danfoss FC202 is the basis of design. Alternate manufacture's shall be considered by the following criteria. A complete submittal with drawings, 10 end users with installations that are 5 years or older that includes contact information for each end user, and this information has to be submitted 10 working days prior to the bid. Alternate manufacturer's will be approved by addenda only.

#### 2.2 General:

- A. Furnish complete VFD as specified herein or in the equipment schedule for loads designated to be variable speed. VFD's shall be user-selectable for either constant or variable torque loads.
- B. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC induction motors. The VFD shall be a six-pulse input design. The VFD shall be of a PWM output design utilizing current IGBT inverter technology and voltage vector control of the output PWM waveform and shall output a waveform that closely approximates a sine wave.
- C. The VFD shall produce an output waveform capable of handling maximum motor cable distances of up to 1,000 ft. (unshielded) without tripping or derating.
- D. The VFD shall utilize VVC<sup>PLUS</sup>, an output voltage-vector switching algorithm, or equivalent, in both variable and constant torque modes. VVC<sup>PLUS</sup> provides rated RMS fundamental voltage from the VFD. This allows the motor to operate at a lower temperature rise, extending its thermal life. VFD's that cannot produce rated RMS fundamental output voltage or require the input voltage to be increased above motor nameplate value to achieve rated RMS fundamental output voltage are not acceptable. VFD's that utilize Sine-Coded PWM or Look-up tables shall not be acceptable.

## VARIABLE FREQUENCY DRIVE (VFD)

- E. An Automatic Energy Optimization (AEO) selection feature shall be provided in the VFD to minimize energy consumption in variable torque applications. This feature shall optimize motor magnetization voltage and shall dynamically adjust output voltage in response to load, independent of speed. Output voltage adjustment based on frequency alone is not acceptable for single motor VT configurations.
- F. The VFD shall be capable of operating the following motor constructions: asynchronous machines as well as permanent magnet (non salient) and synchronous reluctance motors (SynRM).
- G. An Automatic Motor Adaptation (AMA) function shall measure motor stator resistance and reactance to optimize performance and efficiency for all motor constructions. It shall not be necessary to spin the motor shaft or de-couple the motor from the load to accomplish this optimization. Additionally, the parameters for motor resistance and motor reactance shall be user-programmable.
- H. The VFD selected must be able to source the motor's full load nameplate amperage (fundamental RMS) on a continuous basis, and be capable of running the motor at its nameplate RPM, voltage, current, and slip without having to utilize the service factor of the motor.
- I. The VFD shall offer a programmable motor parameter that allows the total number of poles of a motor to be programmed to optimize motor performance.
- J. VFD shall automatically boost power factor at lower speeds.
- K. The VFD will be capable of running either variable or constant torque loads. In variable torque applications, the VFD shall provide a CT-start feature and be able to provide full torque at any speed up to the base speed of the motor. In either CT or VT mode, the VFD shall be able to provide its full rated output current continuously and 110% of rated current for 60 seconds.
- L. A high overload mode of the 3-phase VFD shall enable the drive to provide at least 150% of the rated current for the overload mode or 110% of the rated current for the normal overload as required.
- M. Switching of the input power to the VFD shall be possible without interlocks or damage to the VFD at a minimum interval of 2 minutes.
- N. Switching of power on the output side between the VFD and the motor shall be possible with no limitation or damage to the VFD and shall require no additional interlocks.
- O. The VFD shall have temperature controlled cooling fans for quiet operation, minimized internal losses, and greatly increased fan life.
- P. The VFD shall include an integral RFI filter conforming to the A2 standard as a minimum. VFD enclosures shall be made of metal to minimize RFI and provide additional immunity.
- Q. VFD shall provide full galvanic isolation with suitable potential separation from the power sources (control, signal, and power circuitry within the drive) to ensure compliance with PELV requirements and to protect PLC's and other connected equipment from power surges and spikes.
- R. All inputs and outputs shall be optically isolated. Isolation boards between the VFD and external control devices shall not be required.

## VARIABLE FREQUENCY DRIVE (VFD)

- S. There shall be six fully programmable digital inputs for interfacing with the systems external control and safety interlock circuitry. Two of these inputs shall be programmable as inputs or outputs.
- T. The VFD shall have two analog signal inputs. Inputs shall be programmable for either 0 -10V or 0/4-20 mA.
- U. One programmable analog output shall be provided for indication of the drive status. This output shall be programmable for output speed, voltage, frequency, motor current and output power. The analog output signal shall be 0/4-20 mA.
- V. The VFD shall provide two user programmable relays with 75 selectable functions. Two form 'C' 230VAC/2A rated dry contact relay outputs shall be provided.
- W. An embedded cascade pump controller shall be included to provide lead pump alternation and provide control for up to 3 total pumps. The VFD Pump and 2 other pumps can be controlled either by a starter or soft starter.
- X. The VFD shall accept a N.C. motor over-temperature switch input, as well as possess the capability to accept a motor thermistor input.
- Y. Run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until isolation valves, seal water pumps or other types of auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
- Z. The VFD shall be equipped with a standard RS-485 serial communications port and front-of-drive accessible USB port. Danfoss FC or ModBus RTU communications shall be integrally mounted. A modbus TCP communications card will also need to be provided with the drive to allow communication between the drive and pump monitoring relay.
- AA. A gateway shall be installed to allow the pump monitor protection relay and the drive to communicate via ethernet to the SCADA system.
- BB. The Flygt Mos 801 and 811 shall be installed in the control panel to monitor all alarm conditions of the pump. In the event of alarm this device will be able to de-energize the drive so the pump will not run till the alarm is corrected.
- CC. A unmanaged ethernet switch with 5 RJ45 ports for 10/100Mbps is to be provided to use monitoring of alarm conditions for the VFD and pump faults.
- DD. A Windows® compatible software program to display all monitoring, fault, alarm, and status signals shall be available. This software program shall allow parameter changes, storage of all VFD operating and setup parameters, and remote operation of the VFD. The software shall connect to the VFD with a standard USB cable.

### 2.3 Harmonics

- A. The VFD shall provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor. DC Link reactor shall be installed so that power fluctuations to the DC Capacitors shall be reduced to increase Capacitor life. VFD's without a DC link reactor shall provide a 5% impedance line side reactor and provide spare capacitors.

The VFD shall be provided with line-side harmonic reduction, as required, to insure that the current distortion limits, as defined in table 10.3 of IEEE 519-2014, are met. PCC<sub>1</sub>, defined as the low voltage side of the distribution transformer, is used for purposes of calculation and referred, by the turns ratio of the transformer, to the PCC

## VARIABLE FREQUENCY DRIVE (VFD)

defined by the IEEE Recommended Practices as the Consumer-Utility interface. The tables of limits set forth therein are with reference to the PCC (primary side of the main transformer).

Harmonic solutions shall be designed to withstand up to 2% line imbalances with the maximum Current Distortion not to exceed 5% at 100% load.

Harmonic solutions shall be capable of withstanding up to 2% ambient voltage distortion with the maximum Current Distortion not to exceed 12% at 100% load.

To ascertain the harmonic contribution of the VFD's at the PCC and to show compliance with IEEE 519-2014, harmonic analysis shall be performed and submitted with the bid package, provided that the VFD vendor is in receipt of the below listed information 10 working days prior to the bid date.

- a. kVA rating of the low voltage distribution transformer(s)
  - b. X/R Ratio of utility low voltage distribution transformer(s)
  - c. Primary voltage
  - d. Secondary voltage
  - e. Secondary %IZ (impedance)
  - f. Length, size, & number of conductors between transformer LV side and distribution panel
  - g. System Single Line Diagram and electrical equipment list showing transformer and VFD detail
  - h. Total linear load kW to be connected to the distribution transformer
  - i. Anticipated maximum demand load (15 minute or 30 minute) on the distribution transformer (IEEE 519)
- B. MTE Matrix AP filter with contactor capacitor disconnect shall be install in the control panel to meet the harmonic distortion.

### 2.4 Protective Features:

- A. VFD shall have input surge protection utilizing MOV's, spark gaps, and Zener diodes to withstand surges of 2.3 times line voltage for 1.5 msec.
- B. Printed Circuit boards shall be conformal coated to reduce the corrosion effect from environmental gases and other conditions. The conformal coating must meet IEC 61721-3-3, Class 3C2.
- C. VFD shall include circuitry to detect phase imbalance and phase loss on the input side of the VFD.
- D. VFD shall include current sensors to monitor all three-output phases to detect and report phase loss or unbalance or other power issues to the motor. The VFD will identify which of the output phases is low or lost.
- E. VFD shall auto-derate the output voltage and frequency to the motor if an input phase is lost. This result will maintain operation without decreasing the life expectancy of the VFD. The use of this feature shall be user selectable and export a warning during the event.
- F. VFD shall auto-derate the output voltage and frequency to the motor in the presence of sustained ambient temperatures higher than the normal operating range, so as not to trip on an inverter temperature fault. The use of this feature shall be user-selectable and a warning will be exported during the event. Function shall reduce switching frequency before reducing motor speed.

## VARIABLE FREQUENCY DRIVE (VFD)

- G. VFD shall auto-derate the output frequency by limiting the output current before allowing the VFD to trip on overload. The speed of the load can be reduced, but not stopped.
- H. Low suction pressure and high discharge pressure will be wired in series into the start command of the drive. These will not allow the drive to power the pump and signal through the dry contacts an alarm condition has occurred. The pressure sensors will need to have normally closed contacts that can handle 24vdc. When low suction pressure or high discharge pressure occurs the contacts on the pressure sensors will go from normally closed to open. This will activate the correct light on the panel phase and the dry contact for the SCADA system.

### 2.5 Interface Features:

- A. VFD shall provide an alphanumeric backlit display keypad (LCP) which may be remotely mounted using a standard 9-pin cable. VFD may be operated with keypad disconnected or removed entirely. Keypad may be disconnected during normal operation without the need to stop the motor or disconnect power to the VFD.
- B. VFD Keypad shall feature an INFO key that, when pressed, shall display the contents of the programming manual for the parameter that is currently viewed on the display. The description shall explain the feature and how the settings can be made by the operator.
- C. VFD shall display all faults in plain text; VFD's which can display only fault codes are not acceptable.
- D. The keypad shall feature a 6-line graphical display and be capable of digitally displaying up to five separate operational parameters or status values simultaneously (including process values with the appropriate engineering unit) in addition to Hand/Off/Auto, Local/Remote, and operating status.
- E. Two lines of the display shall allow "free text programming" so that a site description or the actual name of the equipment being controlled by the VFD can be entered into the display.
- F. Keypad shall provide an integral H-O-A (Hand-Off-Auto) and Local-Remote selection capability, and manual control of speed locally without the need for adding selector switches, potentiometers, or other devices.
- G. All VFD's shall be of the same series and shall utilize a common control card and LCP (keypad/display unit) throughout the rating range. The control cards and keypads shall be interchangeable through the entire range of drives used on the project.
- H. VFD keypad shall be capable of storing drive parameter values in non-volatile RAM uploaded to it from the VFD and shall be capable of downloading stored values to the VFD to facilitate programming of multiple drives in similar applications, or as a means of backing up the programmed parameters.
- I. VFD Display shall have the ability to display 5 different parameters pertaining to the VFD or the load including: current, speed, DC bus voltage, output voltage, input signal in mA, or other values from a list of 92 different user-selectable parameters.
- J. VFD display shall indicate which digital inputs are active and the status of each relay.
- K. It shall be possible to toggle between three status read-out screens by pressing the [Status] key. Various operating variables, even with different formatting, can be shown in each status screen.

## VARIABLE FREQUENCY DRIVE (VFD)

- L. VFD display shall indicate the value of any voltage or current signal, including the engineering units of measurement, connected to the analog input terminals.
- M. VFD display shall indicate the value of the current at the analog output terminals, including the engineering units of measurement.
- N. 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.
- O. Two-level password protection shall be provided to prevent unauthorized changes to the programming of the VFD. The parameters can be locked via a digital input and/or the unit can be programmed not to allow an unauthorized user to change the parameter settings.
- P. A quick setup menu with factory preset parameters shall be provided on the VFD to facilitate commissioning. Use of macros shall not be required.
- Q. The software of the VFD shall include a dialogue-based set-up wizard which allows the user to configure common water and waste water applications.
- R. A digital elapsed time meter and kilowatt hour meter shall be provided in the display.
- S. VFD shall offer as standard an internal clock. The internal clock can be used for: Timed Actions, Energy Meter, Trend Analysis, date/time stamps on alarms, Logged data, Preventive maintenance, or other uses. It shall be possible to program the clock for Daylight Saving Time / summertime, weekly working days or non-working days including 20 exceptions (holidays, etc.). It shall be possible to program a Warning in case the clock has not been reset after a power loss.
- T. The VFD shall store in memory the last 10 faults with time stamp and recorded data.
- U. The display (keypad, local control panel) and the software interface of the VFD shall be the same regardless of its power size.

### 2.6 Software Features:

- A. The VFD shall have an adjustable output switching frequency.
- B. Four complete programming parameter setups shall be provided, which can be locally selected through the keypad or remotely selected via digital input(s), allowing the VFD to be programmed for up to four alternate control scenarios without requiring parameter changes.
- C. In each programming set up, independent acceleration and deceleration ramps shall be provided. Acceleration and deceleration time shall be adjustable over the range from 0 to 3,600 seconds to base speed.
- D. The VFD shall have four programmable "Bypass frequencies" with adjustable bandwidths to prevent the driven equipment from running at a mechanically resonant frequency. The feature shall offer a Semi-Automatic program to simplify the set-up.
- E. In each programming setup, independent current limit settings, programmable between 50% and 110% of the drives output current rating, shall be provided.
- F. PID parameter settings shall be adjustable while the VFD is operating, to aid in tuning the control loop at start up. The VFD will also be capable of simultaneously displaying set-point reference and feedback values with appropriate engineering units, as well as output frequency, output current, and run status while programming the PID function.

## VARIABLE FREQUENCY DRIVE (VFD)

- G. The VFD will include a “loss of follower” function to detect the loss of process feedback or reference signals with a live-zero value and a user-selectable choice of responses (go to set speed, min speed, max speed, stop, stop, and trip).
- H. A Sleep Mode function shall be provided to reduce wear and heating of the pump and other equipment in periods where system demand is minimal. This function will operate in both open and closed loop modes:
  - 1. In closed loop process control, when the output speed drops to a user-programmed minimum value (“sleep frequency”) for a specified time (“sleep mode timer”), the drive will enter a sleep mode and either go into standby, or boost mode before entering standby. The drive shall automatically restart the motor once the output of the PID processor exceeds a programmable value “wake up frequency”.
    - A. Boost mode shall prevent short-cycling of the motor by temporarily adjusting the set-point by a user-programmable percentage. Upon reaching this value, the unit will go into standby.
  - 2. In open loop, the drive shall be capable of entering sleep mode if the input reference drops below a user-programmable value. When the input reference increases above a user-programmable reference, the drive will automatically start.
- I. An initial ramp function shall be available to provide a user-selectable ramp, up to 60 seconds, for applications requiring a faster or slower ramp than the normal ramp.
- J. A Dual Ramp feature shall include a Check Valve Ramp and a final Ramp feature. The Check Valve Ramp shall be programmable to gently seat a check valve and reduce the potential of damage from excess pressure while shutting-down the system. Both time and end speed shall be programmable. On the Final Ramp, the VFD shall be programmable to quickly stop the motor after seating of a check valve or for a more rapid stopping than the normal ramp down setting.
- K. VFD shall offer up to 4 separate PID controllers. One controller shall operate the drive in closed loop, while the other 3 provide control signals to other equipment. VFD's with PI controllers only are not acceptable.
- L. An Auto-tuning PI controller output feature shall provide automated PI controller settings. Once the user accepts the settings, the VFD will save the settings to memory.
- M. The software of the VFD shall include a function which allows to start (and stop) an external lubrication device prior to starting the connected motor, after the motor has been stopped or while the motor is running.
- N. An empty pipe fill mode shall be available to fill an empty pipe in a short period of time, and then revert to the PID controller for stable operation. Pipe fill mode shall have a programmable time to reduce water hammer in the system or fill the pipe at a unit per time rate.
- O. Automatic “No-Flow Detection” shall be available to detect a no-flow situation in pump systems where all valves can be closed. This shall be functional in closed loop control or when controlled by an external signal.
- P. Dry-pump detection shall be available to detect if the pump has run dry. If this condition occurs, the drive will be safely stopped. A timer shall be included to prevent nuisance tripping.

## VARIABLE FREQUENCY DRIVE (VFD)

- Q. End-of-Pump curve detection shall stop motor when the pump is operating outside of its programmed pump curve.
- R. The software of the VFD shall include a self-cleaning feature for pumps. This feature shall be available as preventative measure which means that the self-cleaning feature can be initiated at each start, at each stop or at both and as scheduled action. The software shall also allow the user to define the conditions for a self-cleaning event (logic rules). Additionally it shall be possible to program the drive in a way that it detects the condition for a self-cleaning sequence based on deviations in the power consumption of the motor automatically.
- S. The software of the VFD shall include a feature which stops the motor while starting up if an external device hasn't confirmed flow. It shall be programmable in a way that it monitors the digital signal of this device also during the entire operating cycle of the pump.
- T. The VFD shall provide a flow compensation program to reduce energy by adjusting the set point to match changes in flow (friction loss). Flow compensation shall also operate in Cascade control mode.
- U. The VFD shall have a motor preheat function with the ability to be programmed to induce a small amount of current to the motor whenever it is at rest. This will prevent condensation inside the motor and help to extend its life without the need for space heaters or other external equipment.
- V. The VFD will include a user-selectable Auto-Restart function that enables the VFD to power up in a running condition after a power loss, to prevent the need to manually reset and restart the VFD.
- W. The VFD will include a user-selectable Reset function, which enables the selection of between zero and twenty restart attempts after any self-clearing fault condition (under-voltage, over-voltage, current limit, inverter overload, and motor overload), or the selection of an infinite number of restart attempts. The time between restart attempts shall be adjustable from 0 through 600 seconds.
- X. An automatic "on-delay" function may be selected from 0 to 120 seconds.
- Y. VFD shall catch a rotating motor operating either in forward or reverse at up to full speed.
- Z. Common application features and related parameters shall be accessible directly through a separate menu.
- AA. Up to 50 selected parameters and settings shall be accessible directly via a separate, user-defined menu.
- BB. The software of the VFD shall allow to program up to 10 free texts which can be shown on the display of the keypad as info, warnings, or alarms. The conditions or triggers for displaying these texts shall be programmable by the user. The number of the info, warning or alarm shall also be available as status word, warning word or alarm word.

### 2.7 Packaging Options

- A. The enclosure of the drive panel shall be painted steel enclosure of NEMA 12 design. This shall be a painted steel design with the following dimensions 72"Tx36"Wx18"D. Forced air ventilation shall be used to cool the drive cabinet. Air intake and discharge shall be located on the front of the panel so drive panels can be mounted side by side. A thermostat control shall be utilized to control the forced air fans.



## VARIABLE FREQUENCY DRIVE (VFD)

- B. A main circuit breaker disconnect with a rating of 100 KAIC rating will be provided. A lockable disconnect handle will be provided. It will have a mechanism to allow authorized and properly trained personnel to defeat this for testing purposes.
- C. A MTE Sentry DVS dv/dt filter will be installed in the panel to protect the pumps.
- D. The pump manufacture shall supply to the VFD manufacture a pump monitoring relay system with HMI screen. The basis of design is the Flygt MAS BU 811, MAS cU801, and the FOP-402 touch screen.
- E. The following operators shall be provided on the drive panel door. They shall be of 30mm oil/water tight with push button testing to ensure they light is still working properly.
  - a. VFD Run – Green
  - b. VFD Fault – Red
  - c. VFD Power On- White
  - d. VFD Hand/OFF/Auto switch
  - e. VFD Manual Speed potentiometer
  - f. Elapsed time meter to measure VFD run time
  - g. VFD Keypad shall be mounted on drive panel door
  - h. Low suction pressure alarm light(amber)
  - i. High discharge pressure alarm(amber)

### 2.8 Service Conditions:

- A. The ambient operating temperature of the VFD shall be -10°C to 50°C (14 to 122°F), with a 24-hour average not to exceed 45°C. Storage temperatures shall be -13° F (-25° C) to 149/158° F (65/70° C).
- B. 0 to 95% relative humidity, non-condensing.
- C. Elevation to 3,300 feet (1000 meters) without derating.
- D. VFD shall provide full torque to the motor, given input voltage fluctuations of up to +10% to -15% of the rated input voltage (525 to 690VAC, 380 to 480VAC, or 200 to 240VAC). Line frequency variation of  $\pm 2\%$  shall be acceptable.
- E. No side clearance shall be required for cooling of the units.

### 2.9 Spare Parts:

- A. Fan kits for all drive panel fans
- B. Filters
- C. Power fuses
- D. Keypad

## PART 3 – EXECUTION

## VARIABLE FREQUENCY DRIVE (VFD)

### 3.1 Submittals:

- A. Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers, catalog information and catalog cut sheets for all major components.
- B. All drawings shall be in an 8.5 X 11" reproducible format and incorporate the manufacturer's title block on the drawing.
- C. This specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.
- D. Three copies of all submittals shall be provided.
- E. Submit a computer generated Harmonic Distortion Analysis for the jobsite location.

### 3.2 Quality Assurance:

- A. The manufacturer shall be both ISO-9001 and ISO-14001 certified.
- B. All products shall be CE marked; UL labeled, and meet the requirements of UL-508C and maintain cUL.
- C. To ensure quality and minimize infant-mortality failures on the jobsite, each VFD shall be completely tested by the manufacturer. The VFD shall operate a dynamometer at full load and speed under elevated temperature conditions.
- D. All optional features shall be functionally tested at the factory for proper operation.
- E. Factory test documentation shall be available upon request.

### 3.3 Examination:

- A. Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate EMT conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.
- B. The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

### 3.4 Start-up and Warranty

- 1. A factory-authorized service technician shall perform start-up on each drive. ("Start up" shall not include installation or termination of either power or control wiring.) The service technician shall perform start-up on up to 2 drives per day. This means startup days will be 6 days. Start-up costs provided with the bid shall include time and travel for the estimated number of visits required, but shall not be less than at least one half-day with travel. Additional labor or return trips to the site shall be billed at Danfoss' published straight-time rates. Upon completion, a start up service report shall be provided.
- 2. A 6-year on-site warranty shall be provided such that the owner is not responsible for any warranty costs including travel, labor, parts, or other costs for a full 6 years from the date of manufacture of the Drive. The warranty shall cover all Drive failures including line anomalies – including lightning strikes, load anomalies, accidental exposure to moisture or corrosives and accidental collision of other physical damage; product misapplications, vandalism and chronic problems due to the misapplication are not covered. The cost of the warranty shall be included in the bid.

## VARIABLE FREQUENCY DRIVE (VFD)

3. A witness test of each drive shall be allowed and included as a bid option. This testing shall be performed in the factory facility and the drive will be hooked up to a test motor. This test shall include the following: load and control verification. One drive will be tested per day. The owner will be responsible for travel, lodging expenses, and all other miscellaneous expenses while at the factory.

**END OF SECTION**

## 16292 – POWER DISTRIBUTION SYSTEM COORDINATION

### PART 1 - GENERAL

#### 1.01 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.

#### 1.02 PAYMENT

- A. Payment for the power distribution system coordination shall be made as provided for in the Specifications.

#### 1.03 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.
  - 5. IEEE 141, Recommended Practice for Electric Power Distribution Industrial Plants.
  - 6. IEEE 399, Recommended Practice for Industrial and Commercial Power System Analysis.

#### 1.04 SUBMITTALS

- A. Submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions 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. Submit proposed work sequence for the field testing. The sequence shall indicate the schedule of work, time frame and downtime for the equipment. Submit work sequence 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 of five recent references with phone numbers at least 45 days in advance to actual testing.
- C. Reports: Field test report shall be submitted.

#### 1.5 QUALITY ASSURANCE

- A. General:

## 16292 – POWER DISTRIBUTION SYSTEM COORDINATION

1. Perform power system studies 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. 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. 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. Field test the power distribution system. Perform the field testing in accordance with the requirements specified under Article 3.1.
  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. Provide a current and complete short-circuit study, protective device evaluation, arc flash study, and a protective device coordination study for the electrical distribution system. All studies shall contain two scenarios. The first scenario shall utilize the facility engine generator as the power source for all facility loads. The second scenario shall utilize the electric utility feeder as the power source for all facility loads.
  2. The studies shall include all portions of the 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. Perform the short circuit study with the aid of a computer program.
  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.

## 16292 – POWER DISTRIBUTION SYSTEM COORDINATION

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 selectivity 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. Conduct an arc flash study to identify the parameters of the zone of protection and label the Switchgear as per IEEE 1584 requirements.

## 16292 – POWER DISTRIBUTION SYSTEM COORDINATION

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<sup>2</sup>)
  - PPE Level
  - Proposed label
  - Cable length from trip device
  - Incident energy at low marginal
  - Incident energy at high marginal
3. Provide arc flash study labels and affix to the respective switchgear.

### 2.2 STUDY REPORT

- A. Summarize the results of the power system study 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. 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.

## 16292 – POWER DISTRIBUTION SYSTEM COORDINATION

- 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. Submit a field-testing report. The report shall be in accordance with NETA, ATS Acceptance Testing Specification.

END OF SECTION 16292



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## SECTION 16300 - MOTOR STARTERS

### PART 1 - GENERAL

#### 1.01 SCOPE OF WORK

- A. This Section includes all labor, equipment, and materials necessary to furnish and install solid state reduced voltage motor controllers herein referred to as soft starts.

#### 1.02 REFERENCES

- A. National Electrical Manufacturers Association (NEMA) - No. ICS-1, General Standards for Industrial Control and Systems; No. ICS-2, Industrial Control Devices, Controllers and Assemblies; No. ICS-6, Enclosures for Industrial Control and Systems.
- B. ANSI/NFPA 70 - National Electrical Code.
- C. Underwriters Laboratories, Inc. (UL) - No. 845, Motor Control Centers, Electric.

#### 1.03 QUALITY ASSURANCE

- A. The soft start motor starter shall be listed by an independent testing laboratory in accordance with Electric Industrial Control Equipment Specification UL508.
- B. The soft start shall carry the CE mark for indication of compliance to low voltage and EMC directives.
- C. The manufacturer shall be a certified ISP 9002 facility.
- D. The equipment shall be manufactured by Siemens/Furnas.
- E. The brand name product specified was chosen based on past performance and constitute a standard for quality and performance for the specific purpose for which it is intended. Products other than that specified will be considered for use under the provisions set forth as follows:
  - 1. The named products constitute the "Base Bid" system. All bidders are advised to provide "Base Bid" pricing since the magnitude of the expenses involved with engineering redesign or modifications may be difficult to determine during the bidding period. Refer to Section 012500 - Product Options regarding product substitutions.
  - 2. If an alternate unit is proposed, the Supplier shall prepare and submit to the Engineer three (3) paper copies, or a pdf copy, of the "Evaluation Documentation" as listed below. The information shall be in a form that is neat, clear, precise, legible and computer drafted and prepared so as to allow the Engineer to evaluate the proposed equipment.

## SECTION 16300 - MOTOR STARTERS

The "Evaluation Documentation" shall be hand delivered directly to the Engineer at least fifteen (15) calendar days prior to the date set for the bid opening. The pre-bid "Evaluation Documentation" shall consist of the following:

- a. Descriptive technical information for the proposed product(s) highlighted to show the differences between the proposed unit(s) and the specified unit(s). Descriptive technical information shall include model numbers, type, sizes, weights, performance data, and materials of construction.
  - b. List of facilities showing facility name, active contact name and telephone number, years in service, design conditions and parameters and design engineer's name and current telephone number of the company.
  - c. Equipment cuts showing dimensional data for all enclosure components.
3. The Supplier shall state if proposed alternate product is in compliance with each and all Sections of the Specifications. Any variance from the specified equipment shall be listed and a description of each variance must be in letter form. Facsimile transmissions will not be accepted.
  4. Failure to submit the above listed information fifteen (15) calendar days prior to the date set for the bid opening shall be cause for non-evaluation and the product will not be considered for the project.
- F. The Engineer will issue an addendum of approved products prior to the date set for the bid opening.
- G. The acceptance of products prior to the bid date does not relieve the Contractor of his/her responsibility regarding the performance or ability to meet the requirements of the Contract Documents.
- H. After Contract execution, the Contractor shall submit shop drawings of the system as specified herein and in compliance with the requirements contained in Section 01300 - Submittals. The Contractor shall remain fully responsible for all design revisions, including but not limited to, the following: structural, mechanical, electrical, and instrumentation because of utilization of substitute equipment. Refer to Section 01600 – Materials and Equipment for costs associated with redesigns and/or modifications caused by the use of a substitute product offered by the Contractor.
- I. All costs, including other prime contractor, engineering, and legal costs, associated with accommodating alternate equipment shall be borne by the Contractor.

## SECTION 16300 - MOTOR STARTERS

### 1.04 WARRANTY

- A. The equipment furnished under this Section shall be free of defects in design, workmanship, and materials for a period of one (1) year commencing on the date that the equipment was placed in fault free operation. The manufacturer shall repair or replace a defective component during the warranty period free of all charges, including labor.

### 1.05 SUBMITTALS

- A. Submit product data under provisions of Section 01300.
- B. Technical data including, but not limited to electrical ratings, dimensions, mounting, material, running overcurrent protection, branch circuit overcurrent protection, wiring diagrams and accessories.
- C. Operations and Maintenance Manuals prepared in accordance with the requirements contained in Section 01730.

### 1.06 RECORD DRAWINGS

- A. Comply with the requirements contained in Section 01720.

### 1.07 MANUFACTURER SUPPLIED FIELD SERVICES

- A. The Supplier shall supply and credit to the Owner the costs for field services as specified in Section 01660 - Quality Control.
- B. The following field services shall be provided as a minimum in accordance with the requirements contained in Section 01650 - Starting a System:
  - 1. Three (3) days totaling three (3) trips once the system has been installed to check the completed installation, make all necessary adjustments, startup the system, provide operations and maintenance instruction to the Owner, and otherwise place the system into permanent, fault free operation as specified in Section 01650 – Starting of Systems
  - 2. Two (2) days, two (2) trips, approximately three (3) and six (6) months after system startup to review the operation with the Owner and the Engineer and to make system adjustments, as necessary. Dates shall be selected by the Owner and may be used by the Owner any time within a one-(1) year period from the date of initial startup.

## SECTION 16300 - MOTOR STARTERS

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

A. Full Voltage Non-Reversing and Reversing (FVNR):

1. SIEMENS, Class 14.
2. Specifically approved equal.

#### 2.02 MOTOR STARTERS

A. Motor starters shall have the following features:

1. Enclosed type as shown on the Drawings.
2. Circuit breakers within the motor controller enclosures shall have external operating handles with lock-open padlocking provisions and shall indicate the ON and OFF positions.
3. Motor Control Circuits:
  - a. Shall operate at not more than 120 volts.
  - b. Shall be grounded except as follows:
    - 1) Where isolated control circuits as shown.
    - 2) Where manufacturers of equipment assemblies recommend that the control circuits be isolated.
  - c. Incorporate a separate, heavy duty, control transformer within each motor controller enclosure to provide the control voltage for each motor operating over 120 volts.
  - d. Incorporate overcurrent protection for control power transformers in accordance with NFPA 70.
4. Overload Current Protective Devices:
  - a. SIEMENS, Solid State Model ESP100 overloads for all contactors including bypass contactors. Provide only SIEMENS thermal overloads on all output contactors for variable speed drives.

## SECTION 16300 - MOTOR STARTERS

- b. One for each pole.
  - c. Manual reset on the door of each motor controller enclosure to reset Motor from any condition which tripped motor, such as high pressure, overload or incomplete valve cycle.
  - d. Correctly sized for the associated motor's rated full load current.
- 5. Provide three (3) N.C. and (3) N.O. auxiliary contacts, H-O-A, sequence selectors selector switches, pilot lights, and other devices and accessories as shown on the Drawings for each starter.
- 6. Enclosures:
  - a. NEMA Type 4X.
  - b. Where the types of motor controller enclosures are not indicated, they shall be the NEMA types which are the most suitable for the environmental conditions where the motor controllers are being installed.
  - c. Doors mechanically interlocked to prevent opening unless the breaker or switch within the enclosure is open.
  - d. Thoroughly clean and paint the enclosures at the factory with manufacturer's prime coat and standard finish.
- 7. LED Pilot lights shall be press-to test 30.5 mm Heavy Duty Oiltight pushbuttons.
- 8. Pushbuttons and selector switches shall be 30.5 mm Heavy Duty Oiltight.
- B. Motor controllers incorporated with equipment assemblies shall also be designed for the specific requirements of the assemblies.

### 2.03 FULL VOLTAGE STARTERS

- A. All Full Voltage Starters shall be NEMA rated for the load it serves.
- B. Manufacturers: SIEMENS, Class 14.

### 2.04 MISCELLANEOUS CONTROLS AND EQUIPMENT

- A. Provide phase failure/phase reversal relays and voltage sensitive relays for undervoltage and overvoltage protection for all phases. Relays shall be SIEMENS, or approved equal. The

## SECTION 16300 - MOTOR STARTERS

Contacts for these relays shall be in series with all Motor Starter Control Circuits.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Installation shall be in accordance with NFPA 70 and as shown on the Drawings.
- B. All starters shall be factory installed in the Motor Control Center.

+ + END OF SECTION + +

## SECTION 16440 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.01 SECTION INCLUDES

- A. Disconnect switches.
- B. Fuses.
- C. Enclosed Circuit Breakers.

#### 1.02 REFERENCES

- A. NEMA KS-1 - Enclosed Switches.
- B. ANSI/UL 198C - High Intensity Capacity Fuses, Current Limiting Types.
- C. ANSI/UL 198E - Class R Fuses.
- D. FS W-S 865 - Switch, Box (Enclosed), Surface Mounted.
- E. NEMA AB1 - Molded Case Circuit Breakers.

#### 1.03 SUBMITTALS

- A. Submit product data under provisions of Section 01300.
- B. Include outlet drawings with dimensions and equipment ratings for voltage, capacity, horsepower and short circuit current ratings.

#### 1.04 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

### PART 2 - PRODUCTS

#### 2.01 DISCONNECT SWITCHES

- A. Disconnect switches shall be GENERAL ELECTRIC, heavy-duty Type TH or approved equal.
- B. 75°C conductor ratings.
- C. Ratings: 600VAC



## SECTION 16440 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

- D. Quick-break, quick-make, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- E. Suitable for use as service entrance equipment.
- F. Class R 200,000 RMS amps, symmetrical IC.
- G. Class R fusing kit.

### 2.02 FUSES

- A. Fuses shall be Littlefuse KLNK Class RK1 or approved equal.
- B. Fuses shall be rated for 600 volts AC.
- C. Interrupting Rating: 200,000 RMS amps.

### 2.03 MOLDED CASE CIRCUIT BREAKERS

- A. Install molded case circuit breakers for Main Circuit Breaker, Generator Circuit Breaker and Panel Circuit Breakers.
- B. Molded Case Circuit Breaker:
  - 1. Manufacturer: SIEMENS
    - a. 125 Amp, 3 Pole Type ED6.
    - b. 250 Amp, 3 Pole Type HFD6.
    - c. 400Amp, 3 Pole Type HJD6.
    - d. 600Amp, 3 Pole Type HLD6.
    - e. 800Amp, 3 Pole Type HMD6.
  - 2. AIC Rating: 65,000
  - 3. Thermal magnetic with interchangeable trip
- C. Enclosure
  - 1. Manufacturer: SIEMENS

## SECTION 16440 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

2. Rating: NEMA 1 (for interior use) or NEMA 4X Stainless Steel (for exterior use).
3. External Throw.
4. Suitable for Service Entrance Equipment (where applicable).

### 2.04 EXTRA MATERIALS

- A. Furnish one complete set based on number of poles of spare fuses for each fused disconnect switch.

## PART 3 - EXECUTION

### 3.01 INSTALLATION REQUIREMENTS

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Removed temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Provide switches/enclosed circuit breakers at locations as indicated on drawings.
- D. Refer to disconnect switch schedule on drawings for ampacity ratings, fuse sizes, number of poles and enclosure ratings.
- E. Install fuses in fusible devices.
- F. Install engraved nameplates on each switch and enclosed circuit breaker identifying the following:
  1. Switch designated.
  2. Load served.
  3. Power origination.
  4. Fuse size as indicated on drawings.

### 3.02 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

## SECTION 16440 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

- B. Set field-adjustable circuit breaker trip ranges.

+ + END OF SECTION + +

## SECTION 16510 - LIGHTING

### PART 1 - GENERAL

#### 1.01 SECTION INCLUDES

- A. Interior and exterior luminaries and accessories.
- B. Emergency lighting and units.

#### 1.02 REFERENCES

- A. ANSI C78.379 - Electric Lamps - Incandescent and High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns.
- B. ANSI C82.1 - Ballasts for Fluorescent Lamps - Specifications.
- C. ANSI C82.4 - Ballasts for High-Intensity Discharge and Low Pressure Sodium Lamps (Multiple Supply Type).
- D. NEMA WD 6 - Wiring Devices - Dimensional Requirements.
- E. NFPA 70 - National Electric Code.
- F. NFPA 101 - Life Safety Code.

#### 1.03 SUBMITTALS

- A. Submit product data under provisions of Section 01300.
- B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- C. Product Data: Provide dimensions, ratings, performance data and installation instructions.

#### 1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc.

#### 1.05 STORAGE

- A. Store all lamps and fixtures indoors and in their original packages until they are to be installed. Do not leave fixtures or lamps outdoors for any period in time.

## SECTION 16510 - LIGHTING

- B. Tarp light poles until they are to be installed.

### 1.06 SPARE LAMPS

- A. In addition to relamping all fixture lamps that have failed, supply to the Owner spare lamps equal to 10% of the total amount of each type of lamp.
- B. Supply two (2) fixtures of each type specified for indoor locations and one fixture of each type for outdoor locations.
- C. Deliver the spare lamps and fixtures to the Owner at least two (2) weeks prior to the date of anticipated final completion.

## PART 2 - PRODUCTS

### 2.01 LIGHTING UNITS

- A. Provide lighting units as listed in schedule(s).
- B. Provide electronic energy saving ballasts where such options are available.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Install fixtures in accordance with manufacturer's instructions.
- B. Use only stainless-steel mounting hardware regardless of location.
- C. Mount fixtures in locations as shown on drawings and as called for in schedule on electrical drawings. Determine type of ceiling to be installed in each space from drawings and schedules and furnish fixtures suitable for the exact type.
- D. Joints in fixture wiring shall be made using wire nuts, pre-insulated Scotch locks, or other approved mechanical means of connection.
- E. Adjustable type fixtures shall be adjusted by the Contractor to illuminate special areas designated and selected by the Engineer.
- F. Coordinate fixture locations to clear diffusers, ductwork, piping, beams, monorails, vents, and other ceiling mounted equipment. Coordinate the locations of all fixtures with the Engineer and other prime contractors to avoid conflicts. The work of other trades govern the location of light fixtures.

## SECTION 16510 - LIGHTING

- G. Maintain integrity of enclosures on all enclosed and gasketed fixtures. Minimize number of enclosure penetrations and make such penetrations water and dust tight with appropriate gasketing and fittings.
- H. Relamp light fixtures that have failed at completion of project then turn over spare lamps to the Owner.

+ + END OF SECTION + +

SECTION 16510 - LIGHTING

+ + NO TEXT ON THIS PAGE + +

## 16900 - CABLE AND CONDUIT SCHEDULE

### PART 1 - GENERAL

#### 1.01 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 - Electric Conduit System, and Section 16121 - 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.

PART 2 (NOT USED)

PART 3 (NOT USED)

END OF SECTION 16900



+ + NO TEXT ON THIS PAGE + +

NCDP2101 CONTROL CONDUIT AND WIRE SCHEDULE										
Conduit ID	Conduit Type	Conduit Size	No. of Conduit	Wire Type	Wire Size	No. Of Wires	Ground Size	Description	From	To
FE401-FIT401-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE AEROATION	FIT401	FE401
FE403-FIT403-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE AEROATION	FIT403	FE403
FE501-FIT501-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE AEROATION	FIT501	FE501
FE503-FIT503-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE AEROATION	FIT503	FE503
FE601-FIT601-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE AEROATION	FIT601	FE601
FE603-FIT603-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE AEROATION	FIT603	FE603
JB1-SV1-02	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RASP VFD CONTROLLER 1	SV1	JB1
SV1-ATCC1-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	SOUTH RASP VFD CONTROLLER 1	ATCC1	SV1
JB2-SV2-02	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RASP VFD CONTROLLER 2	SV2	JB2
SV2-ATCC1-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	SOUTH RASP VFD CONTROLLER 2	ATCC1	SV2
JB3-SV3-02	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RASP VFD CONTROLLER 3	SV3	JB3
SV3-ATCC1-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	SOUTH RASP VFD CONTROLLER 3	ATCC1	SV3
JB4-SV4-02	RGS	1"	1	STP	#22	1	N/A	SOUTH RASP VFD CONTROLLER 4	SV4	JB4
SV4-ATCC1-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	SOUTH RASP VFD CONTROLLER 4	ATCC1	SV4
JB5-SV5-02	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RASP VFD CONTROLLER 5	SV5	JB5
SV5-ATCC1-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	SOUTH RASP VFD CONTROLLER 5	ATCC1	SV5
FIT091-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	FIT091
FIT101-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	FIT101
FIT121-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	FIT121
FIT111-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	FIT111
FIT141-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	FIT141
FIT131-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	FIT131
FE131-FIT131-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SEDEMENTATION TANK SDB	FIT131	FE131
FIT131-STB1-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB1	FIT131
FE141-FIT141-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SEDEMENTATION TANK SDB	FIT141	FE141
FIT141-STB1-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB1	FIT141
CV131-STB1-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB1	CV131
CV141-STB1-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB1	CV141
FE091-FIT091-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SEDEMENTATION TANK SDB	FIT091	FE091
FIT091-STB2-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB2	FIT091
FE101-FIT101-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SEDEMENTATION TANK SDB	FIT101	FE101
FIT101-STB2-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB2	FIT101
FE111-FIT111-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SEDEMENTATION TANK SDB	FIT111	FE111
FIT111-STB2-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB2	FIT111
FE121-FIT121-01	RGS	3/4"	1	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SEDEMENTATION TANK SDB	FIT121	FE121
FIT121-STB2-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB2	FIT121
CV091-STB2-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB2	CV091
CV101-STB2-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB2	CV101
CV111-STB2-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB2	CV111
CV121-STB2-01	RGS	3/4"	1	STP	#22	1	N/A	SEDEMENTATION TANK SDB	STB2	CV121
STB1-ATCC1-01	EXISTING	1-1/2"	1	STP	#22	6	N/A	SEDEMENTATION TANK SDB	ATCC1	STB1
STB1-ATCC1-02	EXISTING	3/4"	1	XHHW-2	#14	8	N/A	SEDEMENTATION TANK SDB	ATCC1	STB1
STB2-ATCC1-01	EXISTING	2-1/2"	1	STP	#22	12	N/A	SEDEMENTATION TANK SDB	ATCC1	STB2
STB2-ATCC1-02	EXISTING	1"	1	XHHW-2	#14	20	N/A	SEDEMENTATION TANK SDB	ATCC1	STB2
FIT410-CP45410-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4A	CP45410	FIT410
CV410-CP45410-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4A	CP45410	CV410
CP45410-45640-01	RGS	2"	1	12-STRAND FIBER OPTIC CABLE	N/A	1	N/A	EPG LOW PRESSURE 4A	CP45640	CP45410
FIT411A-CP45410G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4A	CP45410G	FIT411A
FIT411B-CP45410G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4A	CP45410G	FIT411B
FIT411C-CP45410G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4A	CP45410G	FIT411C
HVLA1412A-CP45410G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4A	CP45410G	HVLA1412A
HVLA1412B-CP45410G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4A	CP45410G	HVLA1412B
HVLA1412C-CP45410G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4A	CP45410G	HVLA1412C
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FIT420-CP45420-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4B	CP45420	FIT420
CV420-CP45420-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4B	CP45420	CV420
CP45420-45410-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	EPG LOW PRESSURE 4B	CP45410	CP45420
FIT421A-CP45420G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4B	CP45420G	FIT421A
FIT421B-CP45420G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4B	CP45420G	FIT421B
FIT421C-CP45420G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4B	CP45420G	FIT421C
HVLA1422A-CP45420G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4B	CP45420G	HVLA1422A
HVLA1422B-CP45420G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4B	CP45420G	HVLA1422B
HVLA1422C-CP45420G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4B	CP45420G	HVLA1422C
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
FIT430-CP45430-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4C	CP45430	FIT430
CV430-CP45430-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4C	CP45430	CV430
CP45430-45420-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	EPG LOW PRESSURE 4C	CP45420	CP45430
FIT431A-CP45430G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4C	CP45430G	FIT431A
FIT431B-CP45430G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4C	CP45430G	FIT431B
FIT431C-CP45430G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4C	CP45430G	FIT431C
HVLA1432A-CP45430G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4C	CP45430G	HVLA1432A
HVLA1432B-CP45430G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4C	CP45430G	HVLA1432B
HVLA1432C-CP45430G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4C	CP45430G	HVLA1432C
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
FIT440-CP45440-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4D	CP45440	FIT440
CV440-CP45440-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4D	CP45440	CV440
CP45440-45430-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	EPG LOW PRESSURE 4D	CP45430	CP45440
FIT441A-CP45440G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4D	CP45440G	FIT441A
FIT441B-CP45440G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4D	CP45440G	FIT441B
FIT441C-CP45440G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 4D	CP45440G	FIT441C
HVLA1442A-CP45440G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4D	CP45440G	HVLA1442A
HVLA1442B-CP45440G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4D	CP45440G	HVLA1442B
HVLA1442C-CP45440G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 4D	CP45440G	HVLA1442C
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
FIT510-CP45510-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5A	CP45510	FIT510
CV510-CP45510-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5A	CP45510	CV510
CP45510-45440-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	EPG LOW PRESSURE 5A	CP45440	CP45510
FIT511A-CP45510G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5A	CP45510G	FIT511A
FIT511B-CP45510G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5A	CP45510G	FIT511B
FIT511C-CP45510G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5A	CP45510G	FIT511C
HVLA1512A-CP45510G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5A	CP45510G	HVLA1512A
HVLA1512B-CP45510G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5A	CP45510G	HVLA1512B
HVLA1512C-CP45510G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5A	CP45510G	HVLA1512C
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
FIT520-CP45520-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5B	CP45520	FIT520
CV520-CP45520-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5B	CP45520	CV520
CP45520-ATCC2-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	EPG LOW PRESSURE 5B	ATCC2	CP45520
FIT521A-CP45520G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5B	CP45520G	FIT521A
FIT521B-CP45520G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5B	CP45520G	FIT521B
FIT521C-CP45520G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5B	CP45520G	FIT521C
HVLA1522A-CP45520G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5B	CP45520G	HVLA1522A
HVLA1522B-CP45520G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5B	CP45520G	HVLA1522B
HVLA1522C-CP45520G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5B	CP45520G	HVLA1522C
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
FIT530-CP45530-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5C	CP45530	FIT530
CV530-CP45530-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5C	CP45530	CV530
CP45530-ATCC2-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	EPG LOW PRESSURE 5C	ATCC2	CP45530
FIT531A-CP45530G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5C	CP45530G	FIT531A
FIT531B-CP45530G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5C	CP45530G	FIT531B
FIT531C-CP45530G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 5C	CP45530G	FIT531C
HVLA1532A-CP45530G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5C	CP45530G	HVLA1532A
HVLA1532B-CP45530G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5C	CP45530G	HVLA1532B
HVLA1532C-CP45530G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 5C	CP45530G	HVLA1532C
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!







FIT322-CP45320G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 3B	CP45320G	FIT322
FIT323-CP45320G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 3B	CP45320G	FIT323
CV320A-CP45320G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 3B	CP45320G	CV320A
CV320B-CP45320G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 3B	CP45320G	CV320B
CV320C-CP45320G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 3B	CP45320G	CV320C
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
FIT330-CP45330-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 3C	CP45330	FIT330
CV330-CP45330-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 3C	CP45330	CV330
CP45320-45330-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	EPG LOW PRESSURE 3C	CP45330	CP45320
FIT331-CP45330G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 3C	CP45330G	FIT331
FIT332-CP45330G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 3C	CP45330G	FIT332
FIT333-CP45330G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 3C	CP45330G	FIT333
CV330A-CP45330G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 3C	CP45330G	CV330A
CV330B-CP45330G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 3C	CP45330G	CV330B
CV330C-CP45330G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 3C	CP45330G	CV330C
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
FIT340-CP45340-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 3D	CP45340	FIT340
CV340-CP45340-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 3D	CP45340	CV340
CP45330-45340-01	RGS	3/4"	1	CAT-6	N/A	1	N/A	EPG LOW PRESSURE 3D	CP45340	CP45330
FIT341-CP45340G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 3D	CP45340G	FIT341
FIT342-CP45340G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 3D	CP45340G	FIT342
FIT343-CP45340G-01	RGS	3/4"	1	STP	#22	1	N/A	EPG LOW PRESSURE 3D	CP45340G	FIT343
CV340A-CP45340G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 3D	CP45340G	CV340A
CV340B-CP45340G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 3D	CP45340G	CV340B
CV340C-CP45340G-01	RGS	3/4"	1	XHHW-2	#14	10	N/A	EPG LOW PRESSURE 3D	CP45340G	CV340C
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
AE101-DS101-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS101	AE101
AE102-DS102-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS102	AE102
AE103-DS103-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS103	AE103
AE104-DS104-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS104	AE104
AE201-DS201-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS201	AE201
AE202-DS202-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS202	AE202
AE203-DS203-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS203	AE203
AE204-DS204-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS204	AE204
AE301-DS301-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS301	AE301
AE302-DS302-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS302	AE302
AE303-DS303-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS303	AE303
AE304-DS304-01	RGS	3/4"	1	XHHW-2	#12	2	#12	NORTH AERATION	DS304	AE304
AE401-DS401-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS401	AE401
AE402-DS402-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS402	AE402
AE403-DS403-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS403	AE403
AE404-DS404-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS404	AE404
AE501-DS501-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS501	AE501
AE502-DS502-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS502	AE502
AE503-DS503-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS503	AE503
AE504-DS504-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS504	AE504
AE601-DS601-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS601	AE601
AE602-DS602-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS602	AE602
AE603-DS603-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS603	AE603
AE604-DS604-01	RGS	3/4"	1	XHHW-2	#12	2	#12	SOUTH AERATION	DS604	AE604
PIT901B-ATCC3-01	RGS	3/4"	1	STP	#22	1	N/A	NORTH RAS PUMP STATION	ATCC3	PIT901B
PSH901B-V1-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	V1	PSH901B
PIT901A-ATCC3-01	RGS	3/4"	1	STP	#22	1	N/A	NORTH RAS PUMP STATION	ATCC3	PIT901A
PSL901A-V1-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	V1	PSL901A
NPB1-RASPB1-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	RASPB1	NPB1
PIT902B-ATCC3-01	RGS	3/4"	1	STP	#22	1	N/A	NORTH RAS PUMP STATION	ATCC3	PIT902B
PSH902B-V2-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	V2	PSH902B
PIT902A-ATCC3-01	RGS	3/4"	1	STP	#22	1	N/A	NORTH RAS PUMP STATION	ATCC3	PIT902A
PSL902A-V2-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	V2	PSL902A
NPB2-RASPB2-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	RASPB2	NPB2
PIT903B-ATCC3-01	RGS	3/4"	1	STP	#22	1	N/A	NORTH RAS PUMP STATION	ATCC3	PIT903B
PSH903B-V3-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	V3	PSH903B
PIT903A-ATCC3-01	RGS	3/4"	1	STP	#22	1	N/A	NORTH RAS PUMP STATION	ATCC3	PIT903A
PSL903A-V3-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	V3	PSL903A
NPB3-RASPB3-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	RASPB3	NPB3
PIT904B-ATCC3-01	RGS	3/4"	1	STP	#22	1	N/A	NORTH RAS PUMP STATION	ATCC3	PIT904B
PSH904B-V4-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	V4	PSH904B
PIT904A-ATCC3-01	RGS	3/4"	1	STP	#22	1	N/A	NORTH RAS PUMP STATION	ATCC3	PIT904A
PSL904A-V4-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	V4	PSL904A
NPB4-RASPB4-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	RASPB4	NPB4
PIT905B-ATCC3-01	RGS	3/4"	1	STP	#22	1	N/A	NORTH RAS PUMP STATION	ATCC3	PIT905B
PSH905B-V5-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	V5	PSH905B
PIT905A-ATCC3-01	RGS	3/4"	1	STP	#22	1	N/A	0	ATCC3	PIT905A
PSL905A-V5-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	NORTH RAS PUMP STATION	V5	PSL905A
NPB5-RASPB5-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	0	RASPB5	NPB5
PIT907B-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	PIT907B
PSH907B-V6-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	V6	PSH907B
PIT907A-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	PIT907A
PSL907A-V6-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	V6	PSL907A
SPB6-RASPB6-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	RASPB6	SPB6
PIT908B-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	PIT908B
PSH908B-V7-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	V7	PSH908B
PIT908A-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	PIT908A
PSL908A-V7-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	V7	PSL908A
SPB7-RASPB7-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	RASPB7	SPB7
PIT909B-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	PIT909B
PSH909B-V8-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	V8	PSH909B
PIT909A-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	PIT909A
PSL909A-V8-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	V8	PSL909A
SPB8-RASPB8-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	RASPB8	SPB8
PIT910B-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	PIT910B
PSH910B-V9-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	V9	PSH910B
PIT910A-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	PIT910A
PSL910A-V9-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	V9	PSL910A
SPB9-RASPB9-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	RASPB9	SPB9
PIT911B-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	PIT911B
PSH911B-V10-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	V10	PSH911B
PIT911A-ATCC1-01	RGS	3/4"	1	STP	#22	1	N/A	SOUTH RAS PUMP STATION	ATCC1	PIT911A
PSL911A-V10-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	V10	PSL911A
SPB10-RASPB10-01	RGS	3/4"	1	XHHW-2	#12	4	N/A	SOUTH RAS PUMP STATION	RASPB10	SPB10

NCDP2101 POWER CONDUIT AND WIRE SCHEDULE										
Conduit ID	Conduit Type	Conduit Size	Wire Type	No. Of Wires	Wire Size	Ground Size	Description	From	To	
MCCP19-V1-01	EXISTING	2"	THWN	3	#3/0	#6	NORTH RASP	MCCP19	V1	
MCCP19-V1-01	EXISTING	2"	XHHW-2	10	#12	N/A	NORTH RASP	MCCP19	V2	
MCCP19-V2-01	EXISTING	2"	THWN	3	#3/0	#6	NORTH RASP	MCCP19	V2	
MCCP19-V2-01	EXISTING	2"	XHHW-2	10	#12	N/A	NORTH RASP	MCCP19	V3	
MCCP19-V3-01	EXISTING	2"	THWN	3	#3/0	#6	NORTH RASP	MCCP19	V3	
MCCP19-V3-01	EXISTING	2"	XHHW-2	10	#12	N/A	NORTH RASP	MCCP19	V4	
MCCP19-V4-01	EXISTING	2"	THWN	3	#3/0	#6	NORTH RASP	MCCP19	V4	
MCCP19-V4-01	EXISTING	2"	XHHW-2	10	#12	N/A	NORTH RASP	MCCP19	V4	
MCCP19-V5-01	EXISTING	2"	THWN	3	#3/0	#6	NORTH RASP	MCCP19	V5	
MCCP19-V5-01	EXISTING	2"	XHHW-2	10	#12	N/A	NORTH RASP	MCCP19	V5	
V1-JB1-01	EXISTING	2"	THWN	3	#3/0	#6	NORTH RASP	VFD1	JB1	
V1-RASP1-01	EXISTING	2"	XHHW-2	10	#12	N/A	NORTH RASP	VFD1	JB1	
V2-JB2-01	EXISTING	2"	THWN	3	#3/0	#6	NORTH RASP	VFD2	JB2	
V2-RASP2-01	EXISTING	2"	XHHW-2	10	#12	N/A	NORTH RASP	VFD2	JB2	
V3-JB3-01	EXISTING	2"	THWN	3	#3/0	#6	NORTH RASP	VFD3	JB3	
V3-RASP3-01	EXISTING	2"	XHHW-2	10	#12	N/A	NORTH RASP	VFD3	JB3	
V4-JB4-01	EXISTING	2"	THWN	3	#3/0	#6	NORTH RASP	VFD4	JB4	
V4-RASP3-01	EXISTING	2"	XHHW-2	10	#12	N/A	NORTH RASP	VFD4	JB4	
V5-RASP5-01	EXISTING	2"	THWN	3	#3/0	#6	NORTH RASP	VFD5	JB5	
V5-RASP5-01	EXISTING	2"	XHHW-2	10	#12	N/A	NORTH RASP	VFD5	JB5	
LP19A-NJB1-01	EXISTING	1"	XHHW-2	5	#8	N/A	NORTH DISTRIBUTION BOX	LP-19A	NJB1	
LP19A-NJB2-01	EXISTING	1"	XHHW-2	5	#8	N/A	NORTH DISTRIBUTION BOX	LP-19A	NJB2	
MCCP19-NJB1-01	EXISTING	N/A	XHHW-2	3	#10	N/A	NORTH DISTRIBUTION BOX	MCCP19	NJB1	
MCCP19-NJB1-02	EXISTING	N/A	XHHW-2	3	#12	N/A	NORTH DISTRIBUTION BOX	MCCP19	NJB1	
MCCP19-NJB2-01	EXISTING	N/A	XHHW-2	3	#10	N/A	NORTH DISTRIBUTION BOX	MCCP19	NJB1	
MCCP19-NJB2-02	EXISTING	N/A	XHHW-2	3	#12	N/A	NORTH DISTRIBUTION BOX	MCCP19	NJB1	
DS31-NDB31-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	DS31	NDB31	
NJB2-DS31-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	NJB2	DS31	
DS41-NDB41-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	DS41	NDB41	
NJB2-DS41-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	NJB2	DS41	
DS51-NDB51-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	DS51	NDB51	
NJB2-DS51-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	NJB2	DS51	
DS61-NDB61-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	DS61	NDB61	
NJB2-DS61-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	NJB2	DS61	
DS11-NDB11-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	DS11	NDB11	
NJB1-DS11-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	NJB1	DS11	
DS21-NDB21-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	DS21	NDB21	
NJB1-DS21-01	RGS	3/4"	THWN	3	#10	#10	NORTH DISTRIBUTION BOX	NJB1	DS21	
JB1-CCP1-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB1	CCP1	
JB2-CCP3-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB2	CCP3	
JB2-CCP5-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB2	CCP5	
JB3-CCP2-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB3	CCP2	
JB3-CCP4-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB3	CCP4	
JB3-CCP6-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB3	CCP6	
CCP1-MD1-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP1	MD1	
CCP3-MD3-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP3	MD3	
CCP5-MD5-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP5	MD5	
CCP2-MD2-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP2	MD2	
CCP4-MD4-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP4	MD4	
CCP6-MD6-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP6	MD6	
JB4-CCP9-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB4	CCP9	
JB5-CCP10-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB5	CCP10	
JB6-CCP11-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB6	CCP11	
JB7-CCP12-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB7	CCP12	
JB8-CCP13-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB8	CCP13	
JB9-CCP14-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	JB9	CCP14	
CCP9-MD9-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP9	MD9	
CCP10-MD10-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP10	MD10	
CCP11-MD11-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP11	MD11	
CCP12-MD12-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP12	MD12	
CCP13-MD13-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP13	MD13	
CCP14-MD14-01	RGS	3/4"	THWN	3	#12	#12	FINAL SEDIMENTATION	CCP14	MD14	
MM1-SV1-01	EXISTING	2"	THWN	3	#3/0	#6	SOUTHWEST SRAS VFD	MM1	SV1	
MM1-SV1-01	0	0	XHHW-2	10	#12	N/A	0	MM1	SV1	
MM1-SV2-01	EXISTING	2"	THWN	3	#3/0	#6	SOUTHWEST SRAS VFD	MM1	SV2	
MM1-SV2-01	0	0	XHHW-2	10	#12	N/A	0	MM1	SV2	
MM1-SV3-01	EXISTING	2"	THWN	3	#3/0	#6	SOUTHWEST SRAS VFD	MM1	SV3	
MM1-SV3-01	0	0	XHHW-2	10	#12	N/A	0	MM1	SV3	
MM1-SV4-01	EXISTING	2"	THWN	3	#3/0	#6	SOUTHWEST SRAS VFD	MM1	SV4	
MM1-SV4-01	0	0	XHHW-2	10	#12	N/A	0	MM1	SV4	
MM1-SV5-01	EXISTING	2"	THWN	3	#3/0	#6	SOUTHWEST SRAS VFD	MM1	SV5	
MM1-SV5-01	0	0	XHHW-2	10	#12	N/A	0	MM1	SV5	
DS101-CV101-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	DS101	CV101	
SPJB1-DS101-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	SPJB1	DS101	
DS111-CV111-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	DS111	CV111	
SPJB1-DS111-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	SPJB1	DS111	
DS121-CV121-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	DS121	CV121	
SPJB1-DS121-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	SPJB1	DS121	
DS091-CV091-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	DS091	CV091	
SPJB1-DS091-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	SPJB1	DS091	
DS131-CV131-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	DS131	CV131	
SPJB2-DS131-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	SPJB2	DS131	
DS141-CV141-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	DS141	CV141	
SPJB2-DS141-01	RGS	3/4"	THWN	3	#10	#10	SOUTH DISTRABUTION BOX	SPJB2	DS141	
IPMM-SPJB2-01	EXISTING	1"	XHHW-2	5	#8	N/A	SOUTH DISTRABUTION BOX	IPMM	SPJB2	
IPMM-SPJB1-01	EXISTING	1"	XHHW-2	5	#8	N/A	SOUTH DISTRABUTION BOX	IPMM	SPJB1	
MCCM1-SPJB1-01	EXISTING	3/4"	XHHW-2	3	#10	#10	SOUTH DISTRABUTION BOX	MCCM1	SPJB1	
MCCM1-SPJB1-02	EXISTING	3/4"	XHHW-2	3	#10	#10	SOUTH DISTRABUTION BOX	MCCM1	SPJB1	
MCCM1-SPJB1-03	EXISTING	3/4"	XHHW-2	3	#10	#10	SOUTH DISTRABUTION BOX	MCCM1	SPJB1	
MCCM1-SPJB1-04	EXISTING	3/4"	XHHW-2	3	#10	#10	SOUTH DISTRABUTION BOX	MCCM1	SPJB1	
MCCM1-SPJB2-01	EXISTING	3/4"	XHHW-2	3	#10	#10	SOUTH DISTRABUTION BOX	MCCM1	SPJB2	
MCCM1-SPJB2-02	EXISTING	3/4"	XHHW-2	3	#10	#10	SOUTH DISTRABUTION BOX	MCCM1	SPJB2	
MCCP8-NADP-01	RGS	2'	XHHW-2	4	#1/0	#6	EPG MCC (NALV)	MCCP8	NADP	
NADP-TRANS1-01	RGS	1-1/4"	XHHW-2	3	#4	#8	EPG MCC (NALV)	NADP	TRANS1	
TRANS1-NALV-01	RGS	2'	XHHW-2	4	#1/0	#6	EPG MCC (NALV)	TRANS1	NALV	
NALV-CP45110-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (NALV)	NALV	CP45110	
NALV-CP45110G-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (NALV)	NALV	CP45110G	
NALV-CP45120-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (NALV)	NALV	CP45120	
NALV-CP45120G-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (NALV)	NALV	CP45120G	
NALV-CP45130-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (NALV)	NALV	CP45130	
NALV-CP45130G-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (NALV)	NALV	CP45130G	
NALV-CP45140-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (NALV)	NALV	CP45140	
NALV-CP45140G-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (NALV)	NALV	CP45140G	
NALV-CP45210-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (NALV)	NALV	CP45210	
NALV-CP4										











R23TSD-HVLA1632C-01	RGS	3/4"	XHHW-2	3	#12	#12	EPG MCC (DEVICES)	R23TSD	HVLA1632C
R24DSA-FE45640-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (DEVICES)	R24DSA	FE45640
R24DSB-FE45641A-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (DEVICES)	R24DSB	FE45641A
R24DSC-FE45641B-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (DEVICES)	R24DSC	FE45641B
R24DSD-FE45641C-01	RGS	3/4"	XHHW-2	2	#12	#12	EPG MCC (DEVICES)	R24DSD	FE45641C
R24TSA-CV45640-01	RGS	3/4"	XHHW-2	3	#12	#12	EPG MCC (DEVICES)	R24TSA	CV45640
R24TSB-HVLA1642A-01	RGS	3/4"	XHHW-2	3	#12	#12	EPG MCC (DEVICES)	R24TSB	HVLA1642A
R24TSC-HVLA1642B-01	RGS	3/4"	XHHW-2	3	#12	#12	EPG MCC (DEVICES)	R24TSC	HVLA1642B
R24TSD-HVLA1642C-01	RGS	3/4"	XHHW-2	3	#12	#12	EPG MCC (DEVICES)	R24TSD	HVLA1642C
JB1-NV1-01	EXISTING	2"	XHHW-2	3	#3/0	#6	NORTH RAS PUMP STATION	NV1	JB1
JB1-NRAS1-01	FLTM	2"	MANUFACTURER'S SUBMERSIBLE CABLE	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	NORTH RAS PUMP STATION	JB1	NRAS1
JB2-NV2-01	EXISTING	2"	XHHW-2	3	#3/0	#6	NORTH RAS PUMP STATION	NV2	JB2
JB2-NRAS2-01	FLTM	2"	MANUFACTURER'S SUBMERSIBLE CABLE	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	NORTH RAS PUMP STATION	JB2	NRAS2
JB3-NV3-01	EXISTING	2"	XHHW-2	3	#3/0	#6	NORTH RAS PUMP STATION	NV3	JB3
JB3-NRAS3-01	FLTM	2"	MANUFACTURER'S SUBMERSIBLE CABLE	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	NORTH RAS PUMP STATION	JB3	NRAS3
JB4-NV4-01	EXISTING	2"	XHHW-2	3	#3/0	#6	NORTH RAS PUMP STATION	NV4	JB4
JB4-NRAS4-01	FLTM	2"	MANUFACTURER'S SUBMERSIBLE CABLE	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	NORTH RAS PUMP STATION	JB4	NRAS4
JB5-NV5-01	EXISTING	2"	XHHW-2	3	#3/0	#6	NORTH RAS PUMP STATION	NV5	JB5
JB5-NRAS5-01	FLTM	2"	MANUFACTURER'S SUBMERSIBLE CABLE	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	NORTH RAS PUMP STATION	JB5	NRAS5
JB1-SV1-01	EXISTING	2"	XHHW-2	3	#3/0	#6	SOUTH RAS PUMP STATION	SV1	JB1
JB1-SRAS1-01	FLTM	2"	MANUFACTURER'S SUBMERSIBLE CABLE	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTH RAS PUMP STATION	JB1	SRAS1
JB2-SV2-01	EXISTING	2"	XHHW-2	3	#3/0	#6	SOUTH RAS PUMP STATION	SV2	JB2
JB2-SRAS2-01	FLTM	2"	MANUFACTURER'S SUBMERSIBLE CABLE	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTH RAS PUMP STATION	JB2	SRAS2
JB3-SV3-01	EXISTING	2"	XHHW-2	3	#3/0	#6	SOUTH RAS PUMP STATION	SV3	JB3
JB3-SRAS3-01	FLTM	2"	MANUFACTURER'S SUBMERSIBLE CABLE	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTH RAS PUMP STATION	JB3	SRAS3
JB4-NV4-01	EXISTING	2"	XHHW-2	3	#3/0	#6	SOUTH RAS PUMP STATION	SV4	JB4
JB4-SRAS4-01	FLTM	2"	MANUFACTURER'S SUBMERSIBLE CABLE	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTH RAS PUMP STATION	JB4	SRAS4
JB5-SV5-01	EXISTING	2"	XHHW-2	3	#3/0	#6	SOUTH RAS PUMP STATION	SV5	JB5
JB5-SRAS5-01	FLTM	2"	MANUFACTURER'S SUBMERSIBLE CABLE	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTH RAS PUMP STATION	JB5	SRAS5
NJB2-NEFCP2-01	RGS	3/4"	XHHW-2	3	#12	#12	EXHAUST FAN	NJB2	NEFCP2
LP19B-NJB2-01	RGS	3/4"	XHHW-2	3	#12	#12	EXHAUST FAN	LP19B	NJB2
NJB1-NEFCP1-01	RGS	3/4"	XHHW-2	2	#12	#12	EXHAUST FAN	NJB1	NEFCP1
LP19B-NJB1-01	RGS	3/4"	XHHW-2	2	#12	#12	EXHAUST FAN	LP19B	NJB1
SPJB1-SEFCP1-01	RGS	3/4"	XHHW-2	2	#12	#12	EXHAUST FAN	SPJB1	SEFCP1
IPMM-SPJB1-02	RGS	3/4"	XHHW-2	2	#12	#12	EXHAUST FAN	IPMM	SPJB1
SPJB2-SEFCP2-01	RGS	3/4"	XHHW-2	2	#12	#12	EXHAUST FAN	SPJB2	SEFCP2
IPMM-SPJB2-02	RGS	3/4"	XHHW-2	2	#12	#12	EXHAUST FAN	IPMM	SPJB2
NEFCP1-EF1-01	RGS	3/4"	XHHW-2	2	#12	#12	EXHAUSR FAN	NEFCP1	EF1
NEFCP2-EF2-01	RGS	3/4"	XHHW-2	2	#12	#12	EXHAUSR FAN	NEFCP2	EF2
SEFCP1-EF3-01	RGS	3/4"	XHHW-2	2	#12	#12	EXHAUSR FAN	SEFCP1	EF3
SEFCP2-EF4-01	RGS	3/4"	XHHW-2	2	#12	#12	EXHAUSR FAN	SEFCP2	EF4
NEFCP1-PB1-01	RGS	3/4"	XHHW-2	3	#12	#12	EXHAUSR FAN	NEFCP1	PB1
NEFCP2-PB2-01	RGS	3/4"	XHHW-2	3	#12	#12	EXHAUSR FAN	NEFCP2	PB2
SEFCP1-PB3-01	RGS	3/4"	XHHW-2	3	#12	#12	EXHAUSR FAN	SEFCP1	PB3
SEFCP2-PB4-01	RGS	3/4"	XHHW-2	3	#12	#12	EXHAUSR FAN	SEFCP2	PB4
NJB1-EUH1-01	RGS	3/4"	XHHW-2	3	#12	#12	HEATER	NJB1	EUH1
NPJB2-EUH2-01	RGS	3/4"	XHHW-2	3	#12	#12	HEATER	NPJB2	EUH2
SPJB1-EUH3-01	RGS	3/4"	XHHW-2	3	#12	#12	HEATER	SPJB1	EUH3
MCCM1-SPJB1-05	RGS	3/4"	XHHW-2	3	#12	#12	HEATER	MCCM1	SPJB1
SPJB2-EUH4-01	RGS	3/4"	XHHW-2	3	#12	#12	HEATER	SPJB2	EUH4
MCCM1-SPJB2-03	RGS	3/4"	XHHW-2	3	#12	#12	HEATER	MCCM1	SPJB2
FIT31-FE31-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	FIT31	FE31
FIT51-FE51-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	FIT51	FE51
FIT61-FE61-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	FIT61	FE61
FIT41-FE41-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	FIT41	FE41
FIT11-FE11-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	FIT11	FE11
FIT21-FE21-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	FIT21	FE21
NJB2-FIT31-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	NJB2	FIT31
NJB2-FIT51-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	NJB2	FIT51
NJB2-FIT61-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	NJB2	FIT61
NJB2-FIT41-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	NJB2	FIT41
NJB1-FIT11-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	NJB1	FIT11
NJB1-FIT21-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	NJB1	FIT21
LP19A-NJB2-01	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	LP19A	NJB2
LP19A-NJB2-02	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	LP19A	NJB2
LP19A-NJB2-03	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	LP19A	NJB2
LP19A-NJB2-04	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	LP19A	NJB2
LP19A-NJB1-05	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	LP19A	NJB1
LP19A-NJB1-06	RGS	3/4"	XHHW-2	2	#12	#12	TANK FLOW TRANSMITTER	LP19A	NJB1
FIT111-FE111-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	FIT111	FE111
FIT091-FE091-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	FIT091	FE091
FIT101-FE101-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	FIT101	FE101
FIT121-FE121-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	FIT121	FE121
FIT131-FE131-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	FIT131	FE131
FIT141-FE141-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	FIT141	FE141
SJB1-FIT111-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	SJB1	FIT111
SJB1-FIT091-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	SJB1	FIT091
SJB1-FIT101-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	SJB1	FIT101
SJB1-FIT121-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	SJB1	FIT121
SJB2-FIT131-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	SJB2	FIT131
SJB2-FIT141-01	RGS	3/4"	XHHW-2	3	#12	#12	TANK FLOW TRANSMITTER	SJB2	FIT141
DS-FIT091-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH RAS PUMP STATION	DS091	FIT091
DS-FIT101-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH RAS PUMP STATION	DS101	FIT101
DS-FIT121-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH RAS PUMP STATION	DS121	FIT121
DS-FIT111-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH RAS PUMP STATION	DS111	FIT111
DS-FIT141-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH RAS PUMP STATION	DS141	FIT141
DS-FIT131-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH RAS PUMP STATION	DS131	FIT131
FE021-FIT021-01	RGS	3/4"	MANUFACTURER RECOMMENDED	0	MANUFACTURER RECOMMENDED	N/A	WEST PIPE GALLERY-NORTH	FIT021	FE021
FE011-FIT011-01	RGS	3/4"	MANUFACTURER RECOMMENDED	0	MANUFACTURER RECOMMENDED	N/A	WEST PIPE GALLERY-NORTH	FIT011	FE011
FE031-FIT031-01	RGS	3/4"	MANUFACTURER RECOMMENDED	0	MANUFACTURER RECOMMENDED	N/A	WEST PIPE GALLERY-NORTH	FIT031	FE031
FE041-FIT041-01	RGS	3/4"	MANUFACTURER RECOMMENDED	0	MANUFACTURER RECOMMENDED	N/A	WEST PIPE GALLERY-NORTH	FIT041	FE041
FE051-FIT051-01	RGS	3/4"	MANUFACTURER RECOMMENDED	0	MANUFACTURER RECOMMENDED	N/A	WEST PIPE GALLERY-NORTH	FIT051	FE051
FE061-FIT061-01	RGS	3/4"	MANUFACTURER RECOMMENDED	0	MANUFACTURER RECOMMENDED	N/A	WEST PIPE GALLERY-NORTH	FIT061	FE061
DS-FIT011-01	RGS	3/4"	XHHW-2	2	#12	#12	WEST PIPE GALLERY-NORTH	DS	FIT011
DS-FIT011-01	RGS	3/4"	XHHW-2	2	#12	#12	WEST PIPE GALLERY-NORTH	DS	FIT021
DS-FIT011-01	RGS	3/4"	XHHW-2	2	#12	#12	WEST PIPE GALLERY-NORTH	DS	FIT031
DS-FIT011-01	RGS	3/4"	XHHW-2	2	#12	#12	WEST PIPE GALLERY-NORTH	DS	FIT041
DS-FIT011-01	RGS	3/4"	XHHW-2	2	#12	#12	WEST PIPE GALLERY-NORTH	DS	FIT051
DS-FIT011-01	RGS	3/4"	XHHW-2	2	#12	#12	WEST PIPE GALLERY-NORTH	DS	FIT061
FE1091-FIT1091-01	RGS	3/4"	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE PUMP	FIT1091	FE1091
FIT1091-DS1091-01	RGS	3/4"	THWN	2	#12	#12	SOUTHWEST SLUDGE PUMP	DS1091	FIT1091
FE1101-FIT1101-01	RGS	3/4"	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE PUMP	FIT1101	FE1101
FIT1101-FIT1111-01	RGS	3/4"	THWN	2	#12	#12	SOUTHWEST SLUDGE PUMP	FIT1111	FIT1101
FE1111-FIT1111-01	RGS	3/4"	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE PUMP	FIT1111	FE1111
FIT1111-DS1111-01	RGS	3/4"	THWN	2	#12	#12	SOUTHWEST SLUDGE PUMP	DS1111	FIT1111
FE1121-FIT1121-01	RGS	3/4"	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE PUMP	FIT1121	FE1121
FIT1121-DS1121-01	RGS	3/4"	THWN	2	#12	#12	SOUTHWEST SLUDGE PUMP	DS1121	FIT1121
FE1131-FIT1131-01	RGS	3/4"	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE PUMP	FIT1131	FE1131
FIT1131-DS1131-01	RGS	3/4"	THWN	2	#12	#12	SOUTHWEST SLUDGE PUMP	DS1131	FIT1131
FE1141-FIT1141-01	RGS	3/4"	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	MANUFACTURER RECOMMENDED	N/A	SOUTHWEST SLUDGE PUMP	FIT1141	FE1141
FIT1141-DS1141-01	RGS	3/4"	THWN	2	#12	#12	SOUTHWEST SLUDGE PUMP	DS1141	FIT1141
DISCON401-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON401
DISCON402-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON402
DISCON403-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON403
DISCON404-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON404
DISCON501-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON501
DISCON502-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON502
DISCON503-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON503
DISCON504-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON504
DISCON601-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON601
DISCON602-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON602
DISCON603-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON603
DISCON604-ATCC2-01	RGS	3/4"	XHHW-2	2	#12	#12	AERATION	ATCC2	DISCON604
AE101-DS101-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS101	AE101
AE102-DS102-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS102	AE102
AE103-DS103-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS103	AE103
AE104-DS104-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS104	AE104
AE201-DS201-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS201	AE201
AE202-DS202-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS202	AE202
AE203-DS203-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS203	AE203

AE204-DS204-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS204	AE204
AE301-DS301-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS301	AE301
AE302-DS302-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS302	AE302
AE303-DS303-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS303	AE303
AE304-DS304-01	RGS	3/4"	XHHW-2	2	#12	#12	NORTH AERATION	DS304	AE304
AE401-DS401-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS401	AE401
AE402-DS402-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS402	AE402
AE403-DS403-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS403	AE403
AE404-DS404-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS404	AE404
AE501-DS501-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS501	AE501
AE502-DS502-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS502	AE502
AE503-DS503-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS503	AE503
AE504-DS504-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS504	AE504
AE601-DS601-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS601	AE601
AE602-DS602-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS602	AE602
AE603-DS603-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS603	AE603
AE604-DS604-01	RGS	3/4"	XHHW-2	2	#12	#12	SOUTH AERATION	DS604	AE604

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**LIMITED HAZARDOUS MATERIALS SURVEY**

(FOR INFORMATION ONLY – NOT PART OF S3C067-08G CONTRACT DOCUMENTS)

+ + NO TEXT ON THIS PAGE + +

May 31, 2022

Mr. Vincent Falkowski  
 County of Nassau  
 1194 Prospect Avenue  
 Westbury, NY 11590

**Re: Limited Hazardous Materials Survey  
 Nassau County Department of Public Works  
 Cedar Creek WPCP  
 3340 Merrick Road, Wantagh, NY 11793  
 H2M Job No. NCDP2101**

Dear Mr. Falkowski:

In accordance with your request, H2M architects + engineers (H2M) conducted a limited asbestos (ACM), and lead based paint (LBP), inspection at 3340 Merrick Road, Wantagh, NY 11793. The survey was specifically focused on the twelve (12) FSTs, RAS/WAS pump flow meters and process air flow meters. Provided herein are the results of our findings.

#### **Asbestos Sampling**

On April 28 of 2022 - H2M collected limited bulk samples of suspect asbestos containing materials (ACM) that were located at the above-mentioned property and are scheduled to be disturbed during the upcoming project.

Bulk samples were submitted to Amerisci Group Inc (AmeriSci) of New York, New York. AmeriSci is certified by the New York State Department of Health (NYSDOH), Environmental Laboratory Approval Program (ELAP), No. 11480. Bulk samples were collected and submitted by New York State Department of Labor (NYS DOL) certified inspectors Mr. Douglas B. Milne (NYSDOL Cert. No. 13-14307) and Mr. Michael J. Schmitz (NYSDOL Cert. No. 19-01319).

#### **Asbestos Results**

According to the federal Asbestos Hazard Emergency Response Act NESHAP (AHERA), the Occupational Safety and Health Administration (OSHA 1926.1101) and the NYSDOL (12 NYCRR Part 56); asbestos containing material (ACM) is defined as any material or product which contains greater than one percent (1%) of asbestos.

<b>TABLE 1</b> <b>ASBESTOS BULK SAMPLE SUMMARY RESULTS TABLE</b> <b>3340 MERRICK ROAD, WANTAGH, NY, 11793</b>			
<b>LOCATION</b>	<b>MATERIAL DESCRIPTION/ SAMPLE HA #</b>	<b>RESULT FINDINGS</b>	<b>APPROXIMATE QUANTITY OF ACM</b>
South Distribution Tanks	Mud Joint Packing	Non-ACM	--
Table Notes: 1. ACM = Asbestos Containing Material, contains more than 1% by weight in Bold. 2. Non-ACM = Contains ≤1% or no asbestos detected in material samples. 3. All quantities should be verified on site by the contractor prior to submitting a cost estimate or abatement notification/filings. H2M should be notified if there is a change in quantities or work scope. 4. Sq. Ft. = Square Feet, Ln. Ft. = Linear Feet 5. NA = Not Applicable  * - Licensed Abatement contractor must remove in accordance with NYS DOL ICR 56 Assumed ACM materials will require further inspection once access is made available by the contractor.			

### **Lead Based Paint Sampling**

On April 28 of 2022, H2M collected paint chip samples of suspect lead-based paint from painted surfaces of the 3340 Merrick Road, in Wantagh, NY. Sampling was performed by a US EPA Certified Lead Based Paint Inspector, Mr. Michael J. Schmitz (LBP-R-I224702-1).

Paint Chip samples were submitted to EMSL Analytical, Inc. (EMSL) of Carle Place, New York. EMSL is certified by the New York State Department of Health (NYSDOH), Environmental Laboratory Approval Program (ELAP), No. 11469 and EPA 7000B, AAS.

### **Lead Based Paint Results**

According to the U.S. Environmental Protection Agency (US EPA) lead based paint is defined as paint containing equal to or more than 0.5% lead by weight in paint chip samples.

<b>TABLE 2</b> <b>LEAD PAINT BULK SAMPLE SUMMARY RESULTS TABLE</b> <b>3340 MERRICK ROAD, WANTAGH, NY 11793</b>					
<b>Location / Sample #</b>	<b>Room/Component</b>	<b>Substrate</b>	<b>Color</b>	<b>% by Weight</b>	<b>Interpretation</b>
North FST Distribution 1	Stairs	Concrete	Black	<0.0080 %	Non-LBP
North FST Distribution 2	Pipe	Metal	Red	<0.0080 %	Non-LBP
North FST Distribution 3	Conduit	Metal	Gray	<0.0080 %	Non-LBP
North Walkway 4	Steel	Metal	Black	<0.0080 %	Non-LBP
South Walkway 5	Steel	Metal	Black	<0.0080 %	Non-LBP
South Distribution 6	Stairs	Concrete	Gray	0.016 %	LCM*
South Distribution 7	Conduit	Metal	Green	<0.0080 %	Non-LBP
South Distribution 8	Pipe	Metal	Light Blue	<0.0080 %	Non-LBP
West Pipe Gallery 9	WAS Pipe	Metal	Red	0.0082 %	LCM*
West Pipe Gallery 10	North Flow Pipe	Metal	Red	0.18 %	LCM*
West Pipe Gallery 11	South Flow Pipe	Metal	Red	0.011 %	LCM*
East Pipe Gallery 12	North Aeration Pipe	Metal	Gray	<0.0080 %	Non-LBP
<b>Table Notes:</b> 1. Lead Based Paint (LBP) in Bold = EPA defined LBP or lead concentration equal to or above 0.5% by weight. 2. Lab detection reporting limit is 0.008%  * - Lead sample concentration above lab detection limit but below EPA threshold for Lead Based Paint, refer to OSHA 29 CFR 1926.62 for training and handling guidance of Lead Containing Materials (LCM) or incidentally impacted Lead Based Paint (LBP) during construction. Contractor must hold awareness training and reference OSHA 29 CFR 1926.62 and 29 CFR 1910 in working with LCM including proper housekeeping and PPE and disposal and waste characterization requirements.					



Laboratory analytical data sheets and chain of custody forms are provided in Attachment 1. Copies of H2M's licenses and certifications are provided in Attachment 2. Copies of Laboratory certifications are provided in Attachment 3. Photographic documentation is provided in Attachment 4

H2M certifies that the information contained herein is based on the physical data and visual inspections conducted by H2M and lab data collected during the inspection survey. All findings stated in this report are based upon facts and circumstances as they existed at the time of inspection and at the time that this report was prepared. A change in any of the site conditions, facts or circumstances upon which this report is based may affect the findings expressed in this report.

If you have any questions, please do not hesitate to contact the undersigned at (631) 756-8000 extension 1621.

Very truly yours,

**H2M architects + engineers**



Kyle P. Vander Schuyt  
Industrial Hygienist

**ATTACHMENT 1**

LABORATORY ANALYSIS  
&  
CHAIN OF CUSTODY FORM

**EMSL Analytical, Inc.**

528 Mineola Avenue, Carle Place, NY 11514

Phone/Fax: (516) 997-7251 / (516) 997-7528

<http://www.EMSL.com>[carleplacelab@emsl.com](mailto:carleplacelab@emsl.com)

EMSL Order: 062208237

CustomerID: H2ML50

CustomerPO:

ProjectID:

Attn: **Kyle P. Vander Schuyt**  
**H2M Architects and Engineers**  
**538 Broad Hollow Road**  
**4th Floor East**  
**Melville, NY 11747**

Phone: (631) 756-8000  
 Fax:  
 Received: 4/28/2022 11:31 AM  
 Collected: 4/28/2022

Project: **NCDP2101****Test Report: Lead in Paint Chips by Flame AAS (SW 846 3051A/7000B)\***

<i>Client Sample Description</i>	<i>Lab ID</i>	<i>Collected</i>	<i>Analyzed</i>	<i>Lead Concentration</i>
1	062208237-0001	4/28/2022	5/4/2022	<0.0080 % wt
Site: North FST Distribution-Black Stairs				
2	062208237-0002	4/28/2022	5/4/2022	<0.0080 % wt
Site: North FST Distribution-Red Pipe				
3	062208237-0003	4/28/2022	5/4/2022	<0.0080 % wt
Site: North FST Distribution-Light Grey Conduit				
4	062208237-0004	4/28/2022	5/4/2022	<0.0080 % wt
Site: North Walkway-Black Steel				
5	062208237-0005	4/28/2022	5/4/2022	<0.0080 % wt
Site: South Walkway-Black Steel				
6	062208237-0006	4/28/2022	5/4/2022	0.016 % wt
Site: South Distribution-Grey Stairs				
7	062208237-0007	4/28/2022	5/4/2022	<0.0080 % wt
Site: South Distribution-Green Conduit				
8	062208237-0008	4/28/2022	5/4/2022	<0.0080 % wt
Site: South Distribution-Light Blue Pipe				
9	062208237-0009	4/28/2022	5/4/2022	0.0082 % wt
Site: West Pipe Gallery-WAS Pipe Red				
10	062208237-0010	4/28/2022	5/4/2022	0.18 % wt
Site: West Pipe Gallery-North Flow Red Pipe				
11	062208237-0011	4/28/2022	5/4/2022	0.011 % wt
Site: West Pipe South Flow Rd Pipe				
12	062208237-0012	4/28/2022	5/4/2022	<0.0080 % wt
Site: East Pipe Gallery North Aeration Grey Pipe				

Dominique Iaccarino, Chemistry Lab Manager  
 or other approved signatory

EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This report relates only to the samples reported above, and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. Results are generated from the field sampling data (sampling volumes and areas, locations, etc.) provided by the client on the Chain of Custody. Samples are within quality control criteria and met method specifications unless otherwise noted.

Analysis following Lead in Paint by EMSL SOP/Determination of Environmental Lead by FLAA. Reporting limit is 0.008% wt. based on the minimum sample weight per our SOP. "<" (less than) result signifies the analyte was not detected at or above the reporting limit. Measurement of uncertainty is available upon request. Definitions of modifications are available upon request.

Samples analyzed by EMSL Analytical, Inc. Carle Place, NY Lab ID 102344 is accredited by AIHA LAP, LLC in the env. accreditation program for Lead in Paint, CT PH-0249, NYS ELAP 11469, CA 2339

Initial report from 05/05/2022 08:52:11



EMSL ANALYTICAL, INC.  
TESTING LABS • PRODUCTS • TRAINING

## Lead Chain of Custody

EMSL Order Number / Lab Use Only

EMSL Analytical, Inc.  
528 Mineola Avenue  
Carle Place, NY 11514

PHONE: (516) 997-7251

EMAIL: CarleplaceLab@emsl.com

062208237

Customer Information	Customer ID	H2M LSO		Billing Information	Billing ID:	Saver	
	Company Name:	H2M Architects + Engineers			Company Name:		
	Contact Name:	Kyle Vander Schuyt			Billing Contact:		
	Street Address:	290 Broadhollow Rd			Street Address:		
	City, State, Zip:	Melville, NY 11747	Country:				
	Phone:				Phone:		
Email(s) for Report:	Kvanderschuyt@h2m.com		Email(s) for Invoice:				

Project Information			
Project Name/No:	NCDP2101		Purchase Order:
EMSL LIMS Project ID:			US State where samples collected:
(If applicable, EMSL will provide)			State of Connecticut (CT) must select project location:
Sampled By Name	Sampled By Signature:	Commercial (Taxable)	Residential (Non-Taxable)
Kyle Vander Schuyt	Kyle Vander Schuyt	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Turn-Around-Time (TAT)	
<input type="checkbox"/> 3 Hour <input type="checkbox"/> 6 Hour <input type="checkbox"/> 24 Hour <input type="checkbox"/> 32 Hour <input type="checkbox"/> 48 Hour <input type="checkbox"/> 72 Hour <input type="checkbox"/> 96 Hour <input checked="" type="checkbox"/> 1 Week <input type="checkbox"/> 2 Week	Please call ahead for large projects and/or turnaround times 6 Hours or Less. *32 Hour TAT available for select tests only; samples must be submitted by 11:30am.

MATRIX	METHOD	INSTRUMENT	REPORTING LIMIT	SELECTION
CHIPS <input checked="" type="checkbox"/> by wt. <input type="checkbox"/> ppm (mg/kg) <input type="checkbox"/> mg/cm	SW 846-7000B	Flame Atomic Absorption	0.008% (80ppm)	<input type="checkbox"/>
*Reporting Limit based on a minimum 0.25g sample weight	SW 846-6010D*	ICP-OES	0.0004% (4ppm)	<input type="checkbox"/>
AIR	NIOSH 7082	Flame Atomic Absorption	4µg/filter	<input type="checkbox"/>
	NIOSH 7300M / NIOSH 7303M	ICP-OES	0.5µg/filter	<input type="checkbox"/>
	NIOSH 7300M / NIOSH 7303M	ICP-MS	0.05µg/filter	<input type="checkbox"/>
WIPE <input type="checkbox"/> ASTM <input type="checkbox"/> NON-ASTM	SW 846-7000B	Flame Atomic Absorption	10µg/wipe	<input type="checkbox"/>
*If no box is checked, non-ASTM Wipe is assumed	SW 846-6010D*	ICP-OES	1.0µg/wipe	<input type="checkbox"/>
TCLP	SW 846-1311 / 7000B / SM 3111B	Flame Atomic Absorption	0.4 mg/L (ppm)	<input type="checkbox"/>
	SW 846-1311 / SW 846-6010D*	ICP-OES	0.1 mg/L (ppm)	<input type="checkbox"/>
SPLP	SW 846-1312 / 7000B / SM 3111B	Flame Atomic Absorption	0.4 mg/L (ppm)	<input type="checkbox"/>
	SW 846-1312 / SW 846-6010D*	ICP-OES	0.1 mg/L (ppm)	<input type="checkbox"/>
TTLC	22 CCR App. II, 7000B/7420	Flame Atomic Absorption	40mg/kg (ppm)	<input type="checkbox"/>
	22 CCR App. II, SW 846-6010D*	ICP-OES	2mg/kg (ppm)	<input type="checkbox"/>
STLC	22 CCR App. II, 7000B/7420	Flame Atomic Absorption	0.4 mg/L (ppm)	<input type="checkbox"/>
	22 CCR App. II, SW 846-6010D*	ICP-OES	0.1 mg/L (ppm)	<input type="checkbox"/>
Soil	SW 846-7000B	Flame Atomic Absorption	40mg/kg (ppm)	<input type="checkbox"/>
	SW 846-6010D*	ICP-OES	2mg/kg (ppm)	<input type="checkbox"/>
Wastewater	SM 3111B / SW 846-7000B	Flame Atomic Absorption	0.4 mg/L (ppm)	<input type="checkbox"/>
Unpreserved <input type="checkbox"/>	EPA 200.7	ICP-OES	0.020 mg/L (ppm)	<input type="checkbox"/>
Preserved with HNO3 <input type="checkbox"/> PH<2	EPA 200.5	ICP-OES	0.003 mg/L (ppm)	<input type="checkbox"/>
Drinking Water	EPA 200.8	ICP-MS	0.001 mg/L (ppm)	<input type="checkbox"/>
Unpreserved <input type="checkbox"/>				<input type="checkbox"/>
Preserved with HNO3 <input type="checkbox"/> PH<2				<input type="checkbox"/>
TSP/SPM Filter	40 CFR Part 50	ICP-OES	12 µg/filter	<input type="checkbox"/>
Other:				<input type="checkbox"/>

Sample Number	Sample Location	Volume / Area	Date / Time Sampled
1	North FST Distribution - Black Steels	2" x 2"	4/28/22
2	" Red Pipe		
3	" Light Gray Conduit		
4	North Walkway - Black Steel		
5	South Walkway Black Steel		

Method of Shipment:		Sample Condition Upon Receipt:	
Relinquished by:	Date/Time:	Received by:	Date/Time:
[Signature]	4/28/22	[Signature]	4/28/22 1131
Relinquished by:	Date/Time:	Received by:	Date/Time:

Controlled Document - CQC-25 Lead R15 4/5/2021

\*6010C Available Upon Request

☐ AGREE TO ELECTRONIC SIGNATURE (By checking, I consent to signing this Chain of Custody document by electronic signature.)

EMSL Analytical, Inc.'s Laboratory Terms and Conditions are incorporated into this Chain of Custody by reference in their entirety. Submission of samples to EMSL Analytical, Inc. constitutes acceptance and acknowledgment of terms and conditions by Customer.

EMSC Order Number / Lab Use Only  
0622 08237

Additional Pages of the Chain of Custody are only necessary if needed for additional sample information.

Special Instructions and/or Regulatory Requirements (Sample Specifications, Processing Methods, Limits of Detection, etc.)

ENCLOSURE	2022 APR 28	A 11: 31
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Controlled Document - COC-25 Lead R15 4/5/2021

☐ **AGREE TO ELECTRONIC SIGNATURE** (By checking, I consent to signing this Chain of Custody document by electronic signature.)

EMSL Analytical, Inc.'s Laboratory Terms and Conditions are incorporated into this Chain of Custody by reference in their entirety. Submission of samples to EMSL Analytical, Inc. constitutes acceptance and acknowledgment of all terms and conditions by Customer.



Please Reply To:

**AmeriSci New York**

117 EAST 30TH ST.

NEW YORK, NY 10016

TEL: (212) 679-8600 • FAX: (212) 679-3114

***LABORATORY ELECTRONIC TRANSMITTAL***

**To:** Kyle Vander Schuyt

H2M Group

**Fax #:** (631) 271-0787

**Email:** kvanderschuyt@h2m.com

**From:** Bo Sun

**AmeriSci Job #:** 222051070

**Subject:** ELAP-PLM-FRIABLE 5 day Results

**Client Project:** H2M L50; 3340 Merrick Rd,  
Wantagh, NY - Waste Water  
Plant At Cedar Park - Billing #  
NCDP2101

**Date:** Friday, May 6, 2022

**Time:** 12:54:54

**Comments:**

**Number of Pages:** \_\_\_\_\_  
(including cover sheet)

NOTE: Attached report is to be considered preliminary until final review with accompanying analysis summary letter is issued.

CONFIDENTIALITY NOTICE: Unless otherwise indicated, the information contained in this communication is confidential information intended for use of the individual named above. If the reader of this communication is not the intended recipient, you are hereby notified that any dissemination, distribution or copying of this communication is prohibited. If you have received this communication in error, please immediately notify the sender by telephone and return the original message to the above address via the US Postal Service at our expense. Samples are disposed of in 60 days or unless otherwise instructed by the protocol or special instructions in writing. Thank you.

***Certified Analysis***

***Service 24 Hours A Day • 7 Days A Week***

***Competitive Prices***

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**Boston • Los Angeles • New York • Richmond**

**AmeriSci New York**

117 EAST 30TH ST.  
NEW YORK, NY 10016  
TEL: (212) 679-8600 • FAX: (212) 679-3114

## PLM Bulk Asbestos Report

H2M Group  
Attn: Kyle Vander Schuyt  
290 Broad Hollow Road  
Suite 400E  
Melville, NY 11747

**Date Received** 05/02/22 **AmeriSci Job #** 222051070  
**Date Examined** 05/06/22 **P.O. #**  
**ELAP #** 11480 **Page** 1 of 1  
**RE:** H2M L50; 3340 Merrick Rd, Wantagh, NY - Waste Water Plant  
At Cedar Park - Billing # NCDP2101

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1-1 1	222051070-01 <b>Location:</b> South Distribution Tanks - Mud Joint Packing	<b>No</b>	NAD (by NYS ELAP 198.1) by Bo Sun on 05/06/22
<b>Analyst Description:</b> Gray, Homogeneous, Non-Fibrous, Bulk Material <b>Asbestos Types:</b> <b>Other Material:</b> Fibrous glass 15%, Non-fibrous 85%			
1-2 1	222051070-02 <b>Location:</b> South Distribution Tanks - Mud Joint Packing	<b>No</b>	NAD (by NYS ELAP 198.1) by Bo Sun on 05/06/22
<b>Analyst Description:</b> Gray, Homogeneous, Non-Fibrous, Bulk Material <b>Asbestos Types:</b> <b>Other Material:</b> Fibrous glass 10%, Non-fibrous 90%			
1-3 1	222051070-03 <b>Location:</b> South Distribution Tanks - Mud Joint Packing	<b>No</b>	NAD (by NYS ELAP 198.1) by Bo Sun on 05/06/22
<b>Analyst Description:</b> Gray, Homogeneous, Non-Fibrous, Bulk Material <b>Asbestos Types:</b> <b>Other Material:</b> Fibrous glass 10%, Non-fibrous 90%			

**Reporting Notes:**

Analyzed by: Bo Sun  
Date: 5/6/2022

Reviewed by: Bo Sun

\*NAD/NSD =no asbestos detected; NA =not analyzed; NA/PS=not analyzed/positive stop, (SOF-V) = Sprayed On Fireproofing containing Vermiculite; (SM-V) = Surfacing Material containing Vermiculite; PLM Bulk Asbestos Analysis using Olympus, Model BH-2 Pol Scope, Microscope, Serial #: 229003, by Appd E to Subpt E, 40 CFR 763 quantified by either CVES or 400 pt ct as noted for each analysis (NVLAP 200546-0), ELAP PLM Method 198.1 for NY friable samples, which includes the identification and quantitation of vermiculite, or ELAP 198.6 for NOB samples, or EPA 400 pt ct by EPA 600-M4-82-020 (NY ELAP Lab 11480); Note:PLM is not consistently reliable in detecting asbestos in floor coverings and similar non-friable organically bound materials. NAD or Trace results by PLM are inconclusive, TEM is currently the only method that can be used to determine if this material can be considered or treated as non asbestos-containing in NY State (also see EPA Advisory for floor tile, FR 59,146,38970,8/1/94) National Institute of Standards and Technology Accreditation requirements mandate that this report must not be reproduced except in full without the approval of the lab.This PLM report relates ONLY to the items tested. RI Cert AAL-094, CT Cert PH-0186, Mass Cert AA000054, NJ Lab ID #NY031.

\_\_\_\_\_END OF REPORT\_\_\_\_\_



EMSL 528 Mineola Ave, Carle Place, NY 11514 Phone (516) 997-7251 Fax (516) 997-7528



**ATTACHMENT 2**

**H2M'S PERSONNEL LICENSES AND CERTIFICATIONS**

**New York State – Department of Labor**

Division of Safety and Health  
License and Certificate Unit  
State Campus, Building 12  
Albany, NY 12240

**ASBESTOS HANDLING LICENSE**

H2M Architects, Engineers, Land Surveying and  
Landscape Architecture, D.P.C.  
4th Floor East  
538 Broad Hollow Road  
Melville, NY 11747

FILE NUMBER: 00-0724  
LICENSE NUMBER: 28582  
LICENSE CLASS: RESTRICTED  
DATE OF ISSUE: 12/17/2021  
EXPIRATION DATE: 12/31/2022


Duly Authorized Representative – Debra Mattina:

This license has been issued in accordance with applicable provisions of Article 30 of the Labor Law of New York State and of the New York State Codes, Rules and Regulations (12 NYCRR Part 56). It is subject to suspension or revocation for a (1) serious violation of state, federal or local laws with regard to the conduct of an asbestos project, or (2) demonstrated lack of responsibility in the conduct of any job involving asbestos or asbestos material.

This license is valid only for the contractor named above and this license or a photocopy must be prominently displayed at the asbestos project worksite. This license verifies that all persons employed by the licensee on an asbestos project in New York State have been issued an Asbestos Certificate, appropriate for the type of work they perform, by the New York State Department of Labor.

Amy Phillips, Director  
For the Commissioner of Labor

STATE OF NEW YORK - DEPARTMENT OF LABOR  
ASBESTOS CERTIFICATE



**KYLE P VANDERSCHUYT**  
CLASS(EXPIRES)  
C ATEC(09/22) D INSP(09/22)  
H PM (09/22) I PD (09/22)

CERT# 12-11293  
DMV# 879283550


**MUST BE CARRIED ON ASBESTOS PROJECTS**



EYES BRO  
HAIR BRO  
HGT 6' 01"

IF FOUND RETURN TO:  
NYSDOL - L&C UNIT  
ROOM 161A BUILDING 12  
STATE OFFICE CAMPUS  
ALBANY NY 12240

NYC DEP ASBESTOS CONTROL PROGRAM  
ASBESTOS CERTIFICATE



**VANDERSCHUYT,**  
KYLE  
INVESTIGATOR  
149351

EXPIRES: 09/21/2022  
DOB: 09/21/1993 M 6' 00"

**MUST BE CARRIED ON ALL ASBESTOS PROJECTS**



**DMV ID: 879283550**

**This certificate must be shown to a  
NYCDEP representative upon request.  
Report loss immediately to NYCDEP  
Asbestos Control Program, 8th floor  
59-17 Junction Blvd., Flushing, NY 11373**



# United States Environmental Protection Agency

This is to certify that



Kyle P Vander Schuyt

has fulfilled the requirements of the Toxic Substances Control Act (TSCA) Section 402, and has received certification to conduct lead-based paint activities pursuant to 40 CFR Part 745.226 as:

Inspector

In the Jurisdiction of:

All EPA Administered Lead-based Paint Activities Program States, Tribes and Territories

This certification is valid from the date of issuance and expires March 17, 2023

LBP-I-173781-2

Certification #

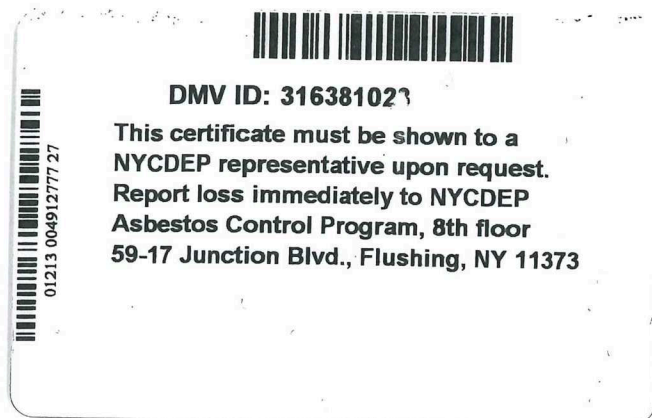
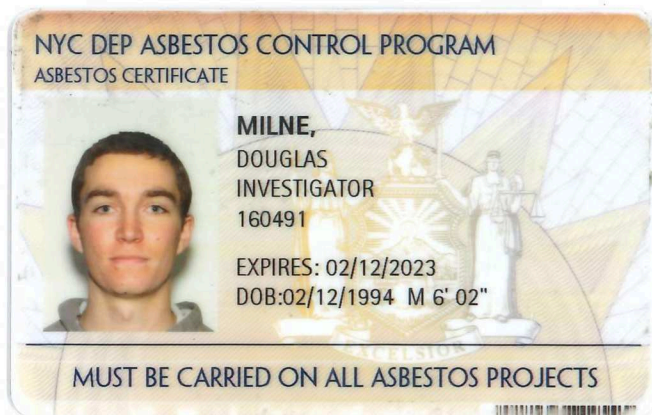
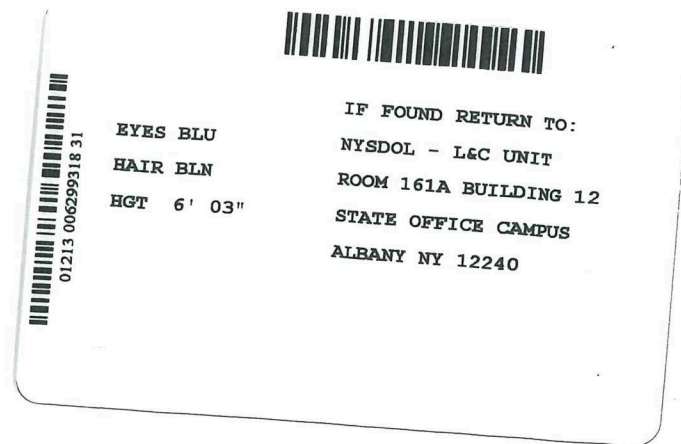
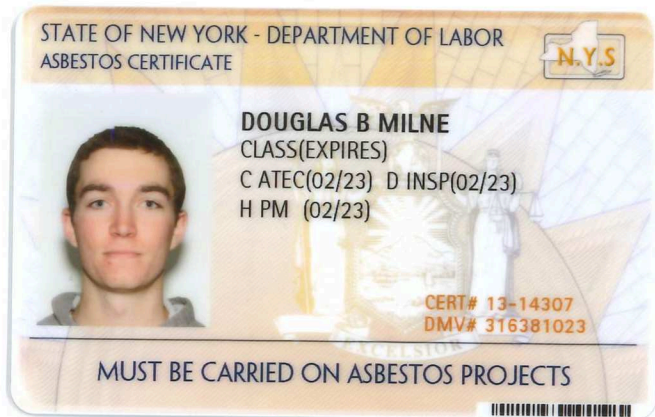
February 21, 2020

Issued On

Susan Schulz, Acting Chief

Chemicals and Multimedia Programs  
Branch







# United States Environmental Protection Agency

This is to certify that



Michael J Schmitz

has fulfilled the requirements of the Toxic Substances Control Act (TSCA) Section 402, and has received certification to conduct lead-based paint activities pursuant to 40 CFR Part 745.226 as:

Risk Assessor

In the Jurisdiction of:

All EPA Administered Lead-based Paint Activities Program States, Tribes and Territories

This certification is valid from the date of issuance and expires June 03, 2024

LBP-R-I224702-1

Certification #

May 20, 2021

Issued On



Ben Conetta, Chief

Chemicals and Multimedia Programs Branch

**ATTACHMENT 3**

EMSL'S CERTIFICATIONS



NEW YORK STATE DEPARTMENT OF HEALTH  
WADSWORTH CENTER



Expires 12:01 AM April 01, 2022  
Issued April 01, 2021

**CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE**

*Issued in accordance with and pursuant to section 502 Public Health Law of New York State*

MR. DANIEL CLARKE  
EMSL ANALYTICAL, INC.  
528 MINEOLA AVE.  
CARLE PLACE, NY 11514

NY Lab Id No: 11469

is hereby APPROVED as an Environmental Laboratory in conformance with the  
National Environmental Laboratory Accreditation Conference Standards (2016) for the category  
**ENVIRONMENTAL ANALYSES POTABLE WATER**  
All approved analytes are listed below:

**Bacteriology**

Coliform, Total / E. coli (Qualitative)	SM 21, 23 9222A,B,C SM 20, 21-23 9223B (-04) (Colilert)
E. coli (Enumeration)	SM 21, 23 9222A,B,C
Enterococci	SM 20, 23 9230C (Budnick 1996)
Heterotrophic Plate Count	SimPlate SM 20, 21-23 9215B (-04)

**Metals I**

Lead, Total	EPA 200.5
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**Miscellaneous**

Asbestos	EPA 100.2
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NEW YORK  
STATE OF  
OPPORTUNITY

Department  
of Health

Serial No.: 62991

Property of the New York State Department of Health. Certificates are valid only at the address shown, must be conspicuously posted, and are printed on secure paper. Continued accreditation depends on successful ongoing participation in the Program. Consumers are urged to call (518) 485-5570 to verify the laboratory's accreditation status.





NEW YORK STATE DEPARTMENT OF HEALTH  
WADSWORTH CENTER



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Issued April 01, 2021

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CARLE PLACE, NY 11514

NY Lab Id No: 11469

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**ENVIRONMENTAL ANALYSES POTABLE WATER**  
*All approved subcategories and/or analytes are listed below:*

**Bacteriology**

Legionella

ISO 11731:2017(E)



Department  
of Health

**Serial No.: 62992**

Property of the New York State Department of Health. Certificates are valid only at the address shown, must be conspicuously posted, and are printed on secure paper. Continued accreditation depends on successful ongoing participation in the Program. Consumers are urged to call (518) 485-5570 to verify the laboratory's accreditation status.



NEW YORK STATE DEPARTMENT OF HEALTH  
WADSWORTH CENTER



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National Environmental Laboratory Accreditation Conference Standards (2016) for the category  
ENVIRONMENTAL ANALYSES NON POTABLE WATER  
All approved analytes are listed below:*

**Bacteriology**

Coliform, Total	SM 9222B-2006
E. coli (Enumeration)	SM 9222B-2006/SM 9222G-2006
Heterotrophic Plate Count	SM 18-21 9215B



Department  
of Health

Serial No.: 62993

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NEW YORK STATE DEPARTMENT OF HEALTH  
WADSWORTH CENTER



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**ENVIRONMENTAL ANALYSES NON POTABLE WATER**  
*All approved subcategories and/or analytes are listed below:*

**Bacteriology**

Legionella

ISO 11731:2017(E)



Department  
of Health

**Serial No.: 62994**

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WADSWORTH CENTER



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NY Lab Id No: 11469

*is hereby APPROVED as an Environmental Laboratory in conformance with the  
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ENVIRONMENTAL ANALYSES SOLID AND HAZARDOUS WASTE  
All approved analytes are listed below:*

**Characteristic Testing**

TCLP EPA 1311

**Metals I**

Lead, Total EPA 7000B

**Sample Preparation Methods**



Department  
of Health

Serial No.: 62995

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NEW YORK STATE DEPARTMENT OF HEALTH  
WADSWORTH CENTER



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528 MINEOLA AVE.  
CARLE PLACE, NY 11514

NY Lab Id No: 11469

*is hereby APPROVED as an Environmental Laboratory for the category  
ENVIRONMENTAL ANALYSES SOLID AND HAZARDOUS WASTE  
All approved subcategories and/or analytes are listed below:*

**Miscellaneous**

Asbestos in Friable Material	Item 198.1 of Manual EPA 600/M4/82/020
Asbestos in Non-Friable Material-PLM	Item 198.6 of Manual (NOB by PLM)
Asbestos in Non-Friable Material-TEM	Item 198.4 of Manual
Asbestos-Vermiculite-Containing Material	Item 198.8 of Manual
Lead in Paint	EPA 7000B

**Sample Preparation Methods**

EPA 3051A

NEW YORK  
STATE OF  
OPPORTUNITY

Department  
of Health

Serial No.: 62996

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NEW YORK STATE DEPARTMENT OF HEALTH  
WADSWORTH CENTER



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Issued April 01, 2021

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EMSL ANALYTICAL, INC.  
528 MINEOLA AVE.  
CARLE PLACE, NY 11514

NY Lab Id No: 11469

*is hereby APPROVED as an Environmental Laboratory in conformance with the  
National Environmental Laboratory Accreditation Conference Standards (2016) for the category  
ENVIRONMENTAL ANALYSES AIR AND EMISSIONS  
All approved analytes are listed below:*

**Miscellaneous**

Particulate Matter

40 CFR PART 50 APP B



Department  
of Health

Serial No.: 62997

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NEW YORK STATE DEPARTMENT OF HEALTH  
WADSWORTH CENTER



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Issued April 01, 2021

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CARLE PLACE, NY 11514

NY Lab Id No: 11469

*is hereby APPROVED as an Environmental Laboratory for the category  
ENVIRONMENTAL ANALYSES AIR AND EMISSIONS  
All approved subcategories and/or analytes are listed below:*

**Metals I**

Lead, Total NIOSH 7082

**Miscellaneous**

Asbestos 40 CFR 763 APX A No. III

YAMATE, AGARWAL GIBB

NIOSH 7402

**Fibers**

NIOSH 7400 A RULES

NEW YORK  
STATE OF  
OPPORTUNITY

Department  
of Health

**Serial No.: 62998**

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ANDREW M. CUOMO  
Governor

## Department of Health

HOWARD A. ZUCKER, M.D., J.D.  
Commissioner

LISA J. PINO, M.A., J.D.  
Executive Deputy Commissioner

LAB ID: 11480

April 01, 2021

MR. PAUL J. MUCHA  
AMERICA SCIENCE TEAM NEW YORK, INC  
117 EAST 30TH ST  
NEW YORK, NY 10016

Certificate Expiration Date:  
April 01, 2022

Dear Mr. Mucha,

Enclosed are certificate(s) of approval issued to your environmental laboratory for the current permit year. The certificate(s) supersede(s) any previously issued one(s) and is(are) in effect through the expiration date listed. Please carefully examine the certificate(s) to insure that the categories, subcategories, analytes, and methods for which your laboratory is approved are correct. In addition, verify that your laboratory's name, address, lead technical director, and identification number are accurate.

Pursuant to NYCRR Subpart 55-2.2, original certificates must be posted conspicuously in the laboratory and copies shall be made available to any client of the laboratory upon request.

Pursuant to NYCRR Subpart 55-2.6, any misrepresentation of the fields of accreditation (category - method - analyte) for which your laboratory is approved may result in denial, suspension, or revocation of your certification. Any use of the Environmental Laboratory Approval Program (ELAP) or National Environmental Laboratory Accreditation Program (NELAP) name, reference to the laboratory's approval status, and/or using the NELAP logo in any catalogs, advertising, business solicitations, proposals, quotations, laboratory analytical reports, or other materials must include the laboratory's ELAP identification number and distinguish between testing for which the laboratory is approved and testing for which the laboratory is not approved.

If you have any questions, please contact us at the Environmental Laboratory Approval Program, Wadsworth Center, New York State Department of Health, Empire State Plaza, Albany NY, 12237; by phone at (518) 485-5570; by facsimile at (518) 485-5568; and by email at [elap@health.ny.gov](mailto:elap@health.ny.gov).

Sincerely,

Victoria Pretti  
Director and QA Officer  
Environmental Laboratory Approval Program



NEW YORK STATE DEPARTMENT OF HEALTH  
WADSWORTH CENTER



Expires 12:01 AM April 01, 2022  
Issued April 01, 2021

**CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE**

*Issued in accordance with and pursuant to section 502 Public Health Law of New York State*

MR. PAUL J. MUCHA  
AMERICA SCIENCE TEAM NEW YORK, INC  
117 EAST 30TH ST  
NEW YORK, NY 10016

NY Lab Id No: 11480

*is hereby APPROVED as an Environmental Laboratory in conformance with the  
National Environmental Laboratory Accreditation Conference Standards (2016) for the category  
ENVIRONMENTAL ANALYSES POTABLE WATER  
All approved analytes are listed below:*

**Miscellaneous**

Asbestos

EPA 100.2

Serial No.: 62999

Property of the New York State Department of Health. Certificates are valid only at the address shown, must be conspicuously posted, and are printed on secure paper. Continued accreditation depends on successful ongoing participation in the Program. Consumers are urged to call (518) 485-5570 to verify the laboratory's accreditation status.

751



NEW YORK STATE DEPARTMENT OF HEALTH  
WADSWORTH CENTER



Expires 12:01 AM April 01, 2022  
Issued April 01, 2021

**CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE**

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MR. PAUL J. MUCHA  
AMERICA SCIENCE TEAM NEW YORK, INC  
117 EAST 30TH ST  
NEW YORK, NY 10016

NY Lab Id No: 11480

*is hereby APPROVED as an Environmental Laboratory for the category  
ENVIRONMENTAL ANALYSES SOLID AND HAZARDOUS WASTE  
All approved subcategories and/or analytes are listed below:*

**Miscellaneous**

Asbestos in Friable Material	Item 198.1 of Manual EPA 600/M4/82/020
Asbestos in Non-Friable Material-PLM	Item 198.6 of Manual (NOB by PLM)
Asbestos in Non-Friable Material-TEM	Item 198.4 of Manual

Serial No.: 63000

Property of the New York State Department of Health. Certificates are valid only at the address shown, must be conspicuously posted, and are printed on secure paper. Continued accreditation depends on successful ongoing participation in the Program. Consumers are urged to call (518) 485-5570 to verify the laboratory's accreditation status.

NEW YORK STATE DEPARTMENT OF HEALTH  
WADSWORTH CENTER



Expires 12:01 AM April 01, 2022  
Issued April 01, 2021

**CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE**

*Issued in accordance with and pursuant to section 502 Public Health Law of New York State*

MR. PAUL J. MUCHA  
AMERICA SCIENCE TEAM NEW YORK, INC  
117 EAST 30TH ST  
NEW YORK, NY 10016

NY Lab Id No: 11480

*is hereby APPROVED as an Environmental Laboratory for the category  
ENVIRONMENTAL ANALYSES AIR AND EMISSIONS  
All approved subcategories and/or analytes are listed below:*

**Miscellaneous**

Asbestos

40 CFR 763 APX A No. III  
YAMATE, AGARWAL GIBB  
NIOSH 7402

Fibers

NIOSH 7400 A RULES

Serial No.: 63001

Property of the New York State Department of Health. Certificates are valid only at the address shown, must be conspicuously posted, and are printed on secure paper. Continued accreditation depends on successful ongoing participation in the Program. Consumers are urged to call (518) 485-5570 to verify the laboratory's accreditation status.

753

**SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017**

**AmeriSci New York**

117 E. 30th Street

New York, NY 10016

Mr. Paul Mucha

Phone: 212-679-8600 Fax: 212-679-2711

Email: [pmucha@amerisci.com](mailto:pmucha@amerisci.com)

<http://www.amerisci.com>

**ASBESTOS FIBER ANALYSIS**

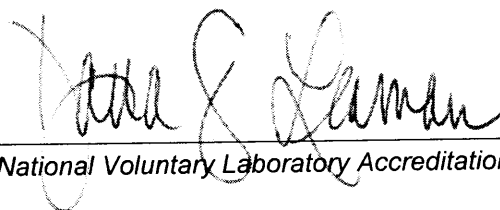
**NVLAP LAB CODE 200546-0**

**Bulk Asbestos Analysis**

<b><u>Code</u></b>	<b><u>Description</u></b>
18/A01	EPA -- 40 CFR Appendix E to Subpart E of Part 763, Interim Method of the Determination of Asbestos in Bulk Insulation Samples
18/A03	EPA 600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials

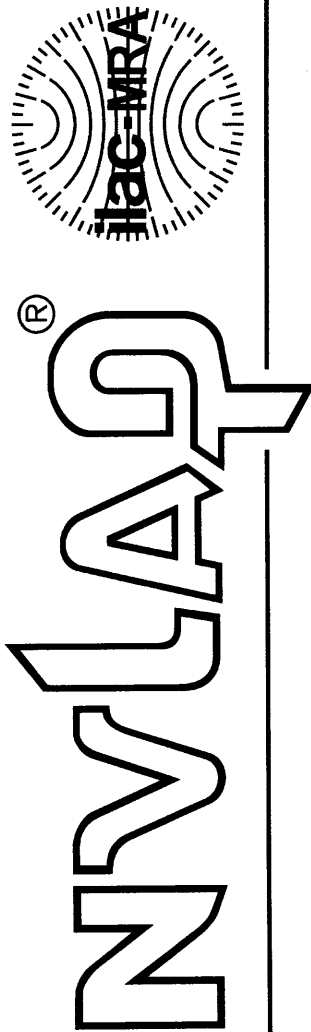
**Airborne Asbestos Analysis**

<b><u>Code</u></b>	<b><u>Description</u></b>
18/A02	U.S. EPA's "Interim Transmission Electron Microscopy Analytical Methods-Mandatory and Nonmandatory-and Mandatory Section to Determine Completion of Response Actions" as found in 40 CFR, Part 763, Subpart E, Appendix A.



For the National Voluntary Laboratory Accreditation Program

United States Department of Commerce  
National Institute of Standards and Technology



# Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 200546-0

**AmeriSci New York**  
New York, NY

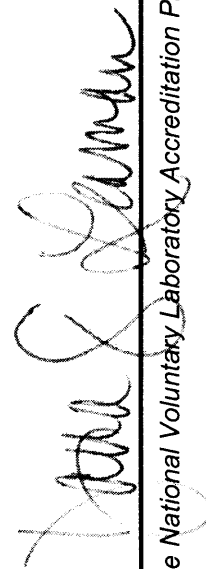
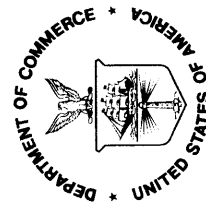
is accredited by the National Voluntary Laboratory Accreditation Program for specific services,  
listed on the Scope of Accreditation, for:

## Asbestos Fiber Analysis

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.  
This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality  
management system (refer to joint ISO-ILAC-IAF Communiqué dated January 2009).

2020-07-01 through 2021-06-30

Effective Dates

A handwritten signature in black ink, which appears to read "Peter J. Langan".

For the National Voluntary Laboratory Accreditation Program

**ATTACHMENT 4**

PHOTOGRAPHIC DOCUMENTATION



North FST Distribution: Non-LBP Red Pipe Paint



North Walkway: Non-LBP Black Stair and Walkway Paint





South Walkway: Non-LBP Black Paint



North FST Distribution: Non-LBP Gray Conduit Paint





South Distribution: Non-LBP Green Paint on metal conduit



South Distribution: LCM\* Gray Stair Paint





West Pipe Gallery: LCM\* North Flow Red Pipe Paint



West Pipe Gallery: LCM\* South Flow Red Pipe Paint



South Distribution Tanks: Non-ACM Mud Joint Packing

+ + NO TEXT ON THIS PAGE + +