

FOR INFORMATIONAL PURPOSES ONLY-DO NOT USE TO PLACE A BID

**FORM OF PROPOSAL
TACKAPAUSHA PARK MUSEUM BUILDING HVAC RENOVATIONS
MECHANICAL CONSTRUCTION
CONTRACT NO. B90644-01H**

Item No.	Type	Description		
1	LUMP SUM	Construction services for Tackapausha Park Museum Building which include: asbestos abatement in the boiler room and attic mechanical rooms, the demolition of existing HVAC Equipment, the cleaning of existing HVAC ductwork, the installation of new equipment, including 2 new unitary units, 1 energy new recovery unit, 2 new split systems complete with interior units, a new humidifier, a new water heater and filter,, 1 new exhaust fan, 7 new ceiling fans, concrete pads for the unitary and split system exterior units, and modifications to the existing gas service.		
2	LUMP SUM	Include in bid an allowance for contingency item of ninety thousand (\$90,000) for unforeseen conditions.	\$90,000.00	

BASIS OF AWARD: Bids on Lump Sum Contracts will be compared on the basis of the total bid price, arrived at by taking the Sum of each Bid Item, including Allowance Item(s), if any, and plus or minus the cost difference of the Alternate(s), if any, as may be selected by the Architect and/or Owner. The sum of all "Amounts Bid" will determine the low bid and the subsequent award of this Contract.

BID SECURITY: Prospective bidders are cautioned to carefully review the requirements of Paragraph H, Bid Security, of The Instructions to Bidders.

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**FORM OF PROPOSAL
TACKAPAUSHA PARK MUSEUM BUILDING HVAC RENOVATIONS
ELECTRICAL CONSTRUCTION
CONTRACT NO. B90644-01E**

Item No.	Type	Description		
1	LUMP SUM	Construction services for Tackapausha Park Museum Building which includes all electrical work associated with the following: the demolition of existing HVAC Equipment, the installation of new equipment, including 2 new unitary units, 1 energy new recovery unit, 2 new split systems complete with interior units, a humidifier, a new water heater, 1 new exhaust fan, and new electric heaters.		
2	LUMP SUM	Include in bid an allowance for contingency item of ten thousand (\$10,000) for unforeseen conditions.	\$10,000.00	

BASIS OF AWARD: Bids on Lump Sum Contracts will be compared on the basis of the total bid price, arrived at by taking the Sum of each Bid Item, including Allowance Item(s), if any, and plus or minus the cost difference of the Alternate(s), if any, as may be selected by the Architect and/or Owner. The sum of all "Amounts Bid" will determine the low bid and the subsequent award of this Contract.

BID SECURITY: Prospective bidders are cautioned to carefully review the requirements of Paragraph H, Bid Security, of The Instructions to Bidders.

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SECTION 01100

SUMMARY OF WORK

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification: This contract is for construction services to demolish and replace existing HVAC systems at the Tackapausha Park Museum..
- B. Engineer Identification: The Contract Documents were prepared for this project by the Nassau County Department of Public Works, 1194 Prospect Avenue, Westbury, NY 11590. The existing equipment at this facility is over 50 years old, and is well past its useful life. The existing HVAC systems will be demolished, the existing HVAC ductwork will be cleaned, and new HVAC systems will be installed. The new HVAC work will include 2 new unitary units, 1 energy recovery unit, 2 split systems complete with interior units, electric heaters, a water heater, 1 exhaust fan, the addition of ceiling fans in some areas, modifications to the existing gas service, and all required electrical work. Asbestos abatement of the existing boiler room and attic mechanical room will also be part of this work.
- C. The Project will be constructed under two prime construction contracts.

1.2 WORK SEQUENCE

- A. The Project has work sequencing requirements to ensure that critical facility operations remain in effect during construction activities. Work sequencing requirements are detailed on the drawings.

1.3 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 16-division format and CSI/CSC's "Master Format" numbering system.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
 - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01140

WORK RESTRICTIONS

PART 1 GENERAL

1.1 USE OF PREMISES

- A. Use of Site: Limit use of site to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated.
 - 1. Limits: Confine constructions operations to limits as indicated on the plans.
 - 2. Owner Occupancy: Allow Owner full occupancy of site.
 - 3. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to County, County employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Use of Existing Buildings: As applicable - Maintain existing buildings in a weathertight condition throughout construction period. Repair any site damage caused by construction operations. Protect nearby buildings/storage units/fencing during construction period.

1.2 OCCUPANCY REQUIREMENTS

- A. No Occupancy: These facilities will have limited occupancy by county employees and the general public until all work is completed. Schedule work accordingly. Fence, cone or tape off areas to the general public as to prevent access to active work areas. (Have an employee on site as to enforce this when construction is active.)

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01230

ALTERNATES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for alternates.

1.2 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.3 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01260

CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications. In case of any conflicts or inconsistencies between this Section and Sections entitled "Notice to Bidders", "Instructions to Bidders", "Proposal Forms", "Conditions of Contract", "General Conditions" or "Form of Contract", the above-named sections shall govern.
- B. See Division 1 Section "Unit Prices" for administrative requirements for using unit prices.

1.2 MINOR CHANGES IN THE WORK

- A. Engineer will issue written supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

1.3 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Proposal Requests issued by Engineer are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
 - 2. Within 5 days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
- B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the

Contract, Contractor may propose changes by submitting a request for a change.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time
5. Comply with requirements in Division 1 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.

1.4 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor

1.5 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Engineer may issue a written Construction Change Directive. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

END OF SECTION

SECTION 01290

PAYMENT PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment. In case of any conflicts or inconsistencies between this Section and Sections entitled "Notice to Bidders", "Instructions to Bidders", "Proposal Forms", "Conditions of Contract", "General Conditions" or "Form of Contract", the above-named sections shall govern.

1.2 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
 - 1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including Submittals Schedule and Application for Payment forms with Continuation Sheets.
 - 2. Submit the Schedule of Values to Engineer at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
 - 3. Sub-schedules: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules showing values correlated with each phase of payment.
- B. Format and Content:
 - 1. Identification: Include the following Project identification on the Schedule of Values:
 - a. Project name and location.
 - b. Name of Engineer.
 - c. Engineer's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 - 2. Arrange the Schedule of Values in tabular form with separate columns to indicate

the following for each item listed:

- a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value.
 - 1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
 4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
 5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 6. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
 7. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
 8. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.3 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by Engineer and paid for by Owner.
 - 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.
- C. Payment Application Forms: Use forms provided by Owner.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Engineer will return incomplete applications without action.
 - 1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
 - 2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- E. Transmittal: Submit 2 signed and notarized original copies, plus an amount requested by the Owner, of each Application for Payment to Engineer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
 - 1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- F. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
 - 1. Submit partial waivers on each item for amount requested, before deduction for retainage, on each item.
 - 2. When an application shows completion of an item, submit final or full waivers.
 - 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 - 4. Waiver Delays: Submit each Application for Payment with Contractor's waiver of mechanic's lien for construction period covered by the application.
 - a. Submit final Application for Payment with or preceded by final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.

- G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of Values.
 3. Contractor's Construction Schedule (preliminary if not final).
 4. Submittals Schedule (preliminary if not final).
 5. List of Contractor's staff assignments.
 6. Copies of building permits.
 7. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 8. Certificates of insurance and insurance policies.
 9. Performance and payment bonds.
 10. Data needed to acquire Owner's insurance.
- H. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- I. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum.
 4. Evidence that claims have been settled.

5. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01310

PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on the Project. In case of any conflicts or inconsistencies between this Section and Sections entitled "Notice to Bidders", "Instructions to Bidders", "Proposal Forms", "Conditions of Contract", "General Conditions" or "Form of Contract", the above-named sections shall govern. This Section includes, but is not limited to, the following:
 - 1. General Project coordination procedures.
 - 2. Coordination Drawings.
 - 3. Project meetings.

1.2 COORDINATION

- A. Coordination: Coordinate construction operations included in various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Make adequate provisions to accommodate items scheduled for later installation.
 - 3. Coordinate inspections by authorities having jurisdiction over installed components as required.
- B. If necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and utilities surveyors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule.
 2. Preparation of the Schedule of Values
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress Meetings.
 6. Pre-installation conferences.
 7. Project closeout activities.
- D. The Contractor shall employ a competent full-time superintendent who shall be in attendance at the job site whenever work is being performed under the contract, for the entire duration of the project and who shall be responsible for securing the site and buildings on a daily basis.
- E. All construction work on this project must be performed in compliance with the Occupational Safety and Health Act of 1970 or with Local or State occupational safety and health regulations enforced by an agency of the locality of state under a plan approved by the U.S. Department of Labor Occupation Safety and Health Administration (OSHA).
- F. The Contractor must layout its work from benchmarks established at the project site and is responsible for all measurements based on them. The contractor must furnish, at his/her own expense, all equipment, tools, materials, and labor as may be required in the layout of any part of the work.
- G. The contractor must cooperate fully and must schedule his/her work accordingly in making connections to utilities during the construction period. The contractor must contact, coordinate, and make the necessary arrangements with the respective authorities for the connections to the utilities required under the contract.

1.3 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
1. Indicate relationship of components shown on separate Shop Drawings.
 2. Indicate required installation sequences.
 3. Refer to individual specifications for coordination drawings as required.

1.4 PROJECT MEETINGS

Tackapausha Park Museum Building HVAC System Renovations
B90644-01H,E

- A. General: Attend meetings and conferences at Project site, unless otherwise indicated.
- B. Preconstruction Conference: Attend a preconstruction conference before starting construction, no later than 15 days after execution of the Agreement.
 - 1. Attendees: Authorized representatives of County, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing.
 - d. Designation of responsible personnel.
 - e. Procedures for processing field decisions and Change Orders.
 - f. Procedures for processing Applications for Payment.
 - g. Distribution of the Contract Documents.
 - h. Submittal procedures.
 - i. Preparation of Record Documents.
 - j. Use of the premises.
 - k. Responsibility for temporary facilities and controls.
 - l. Parking availability.
 - m. Work, and storage areas.
 - n. Equipment deliveries and priorities.
 - o. First aid.
 - p. Security.
 - q. Progress cleaning.
 - r. Working hours.

- C. Progress Meetings: Attend progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.
1. Attendees: In addition to representatives of County and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Work hours.
 - 10) Hazards and risks.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Change Orders.

- 14) Documentation of information for payment requests.

1.5 SECURITY

- A. Contractor shall be responsible for securing all equipment, supplies, etc. stored on site for the duration of the project.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01320

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work. In case of any conflicts or inconsistencies between this Section and Sections entitled “Notice to Bidders”, “Instructions to Bidders”, “Proposal Forms”, “Conditions of Contract”, “General Conditions” or “Form of Contract”, the above-named sections shall govern. This Section includes, but is not limited to, the following:
 - 1. Contractor's Construction Schedule.
 - 2. Submittals Schedule.
 - 3. Daily construction reports.
 - 4. Field condition reports.
 - 5. Construction photographs.

1.2 DEFINITIONS

- A. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- B. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
- C. Fragment: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- D. Major Area: A significant construction element.

1.3 SUBMITTALS

- A. Submittals Schedule: Submit six copies of schedule. Arrange the following information in a tabular format:
 - 1. Scheduled date for first submittal.

2. Specification Section number and title.
 3. Submittal category (action or informational).
 4. Name of subcontractor.
 5. Description of the Work covered.
 6. Scheduled date for Engineer's final release or approval.
- B. Contractor's Construction Schedule: Submit six printed copies of initial schedule, one a reproducible print and one a blue- or black-line print, large enough to show entire schedule for entire construction period.
- C. CPM Reports: Concurrent with CPM schedule, submit six printed copies of each of the following computer-generated reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float.
1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 3. Total Float Report: List of all activities sorted in ascending order of total float.
- D. Construction Photographs: Submit digital photographs to the Engineer within seven days of taking photographs. Submit two binders including printed photographs upon completion of the project.
1. Digital Format: Digital photographs taken with a min. 3.0 MP camera, with time and date stamp.
 2. Printed Format: Digital photographs printed on 8"x10" photographic paper. Photographs shall be punched and mounted in a three-ring binder.
 3. Digital Photograph Identification: In the transmittal for the photographs, provide the following for each photograph:
 - a. Project Site.
 - b. Date and time photograph was taken.
 - c. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

4. Printed Photograph Identification: On back of each print, provide an applied label or rubber-stamped impression with the following:
 - a. Project Site.
 - b. Date and time photograph was taken.
 - c. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
- E. Daily Construction Reports: Submit two copies at weekly intervals.
- F. Field Condition Reports: Submit two copies at time of discovery of differing conditions.

1.4 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
 1. Secure time commitments for performing critical elements of the Work from parties involved.
 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 PRODUCTS

2.1 SUBMITTALS SCHEDULE

- A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
 1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
 2. Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording events at Project site, including the following:

1. List of subcontractors.
 2. High and low temperatures and general weather conditions.
 3. Accidents.
 4. Stoppages, delays, shortages, and losses.
 5. Meter readings and similar recordings.
 6. Orders and requests of authorities having jurisdiction.
 7. Services connected and disconnected.
 8. Equipment or system tests and startups.
- B. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare a detailed report. Submit with a request for information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

PART 3 EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At weekly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate Actual Completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

3.2 CONSTRUCTION PHOTOGRAPHS

- A. Periodic Construction Photographs: Take photographs periodically during the removal and installation of tanks, dispensers, piping, and appurtenances. Photographer shall select vantage points to best show status of construction and progress since last photographs were taken.
 - 1. Field Prints: Retain one set of prints of periodic photographs in field at Project site, available at all times for reference. Identify photographs the same as for those submitted to Engineer.

END OF SECTION

SECTION 01325
CPM (CRITICAL PATH METHOD) PROGRESS SCHEDULE
(SINGLE PRIME)

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 P3 software.
- B. The purpose of the computerized CPM progress schedule is to ensure timely completion of the contract and to establish a standard methodology for time adjustment analysis based on the principles of the Critical Path Method of Scheduling.
- C. For this specification, "Engineer" means County authorized Construction Manager.
- D. The Contractor shall ensure that any and all computer files submitted to the Engineer are in a format that can be imported directly using Primavera software, version P3 (or as approved by the Engineer).

1.2 DETAILS

- A. PRE CONSTRUCTION SCHEDULE MEETING
 - 1. The Engineer will schedule and conduct a Pre-construction Scheduling Meeting with the Contractor within ten (10) working days after the contract has been awarded. The requirements of this specification will be reviewed at this meeting. Additionally the following topics will be discussed:
 - a. Specifics of any contract Time-Related Clauses.
 - b. The representation in the schedule of the Time Related work.
 - c. The calendar, activity coding, and resource definition requirements unique to and consistent with the contract.
 - d. The Contractor's schedule methodology employed, proposed work sequence and any proposed deviations of sequences from the contract plans.
 - e. The factors that the Contractor determines to control the completion of the project and any milestone completions contained therein.
 - f. Narrative content for Initial Baseline and Monthly Updates.
 - g. Schedule submission protocol for Initial Baseline and Monthly Updates.

2. The Contractors attendance at the Pre construction Scheduling Meeting is mandatory. No field work will be allowed, with the exception of set up of the field office, until this meeting is held.

B. INITIAL BASELINE CPM CONSTRUCTION SCHEDULE

1. Within fifteen (15) 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 shop drawing and procurement related items. The Initial Baseline CPM Construction Schedule must be set up to conform to the staging/phasing and other requirements defined in 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. (If the contractor desires to employ an alternative method prior approval by the Engineer is required and no changes to the initial submission date will be permitted.)
 - 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. 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. Shop drawing review.
 - e. Any project specifics as required by the Engineer.

- f. Expected and contemplated weather conditions shall be accounted for in the calendars.
- 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** bid breakdown.
- 5. ACTIVITY DATA
 - a. ACTIVITY IDENTIFICATION - Each activity shall have a unique identifier. The identifier may be alpha-numeric, but at a minimum must be a unique number.
 - b. ACTIVITY DESCRIPTION - Each activity shall be unambiguously described. Descriptions such as "construct 30% of Y" are unacceptable. Activities shall be discrete to the extent necessary to accurately schedule the work.
 - c. ACTIVITY DURATION - Durations of individual work activities shall not exceed fifteen 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 Award" 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 RESOURCE S-** 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:

<u>Activity ID</u>	<u>Activity Description</u>	<u>Activity Type</u>	<u>Logic Relationship</u>
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 last 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 Sorts 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

- a. 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.
- b. A Narrative Report is required for each update and shall provide the following information:
 1. Contractors transmittal letter to the Engineer stating the update period and schedule "Data Date".
 2. Work started, completed and ongoing during the update period by activity with "Actual Dates".
 3. Description of current Critical Path and any change from previous Critical Path.
 4. Any activities added or deleted and any proposed changes in Activity Logic (Engineer's approval in writing is required).
 5. Current Delays or Advancements
 - a. Delayed or Advanced Activities.

- b. Proposed corrective action and schedule adjustments to address the Delay.
 - c. Impact of Delay or Advancement on other activities (duration, ES,EF,LS,LF), milestone and completion dates.
 - d. Impact of Delay or Advancement on the Critical Path.
 - 6. Outstanding Items that effect the schedule and status thereof (including but not limited to):
 - a. Permits.
 - b. Shop Drawings.
 - c. Change Orders.
 - d. Reviews of submittals.
 - e. Approvals.
 - f. Fabrication and Delivery.
 - 7. Scheduled Completion Date Status
 - a. Contract Completion.
 - b. Interim Time Frame if any.
- 2. The following Activity Sorts generated from the Software shall be provided:
 - a. Current Critical Path Activity Sort
 - b. Near Critical Activities Sort
 - c. Sort of Activities scheduled to start (ES) & finish (EF) in the next Monthly update period.
 - d. Any other “sort” as directed by the Engineer and/or as discussed in the pre-construction scheduling meeting.
- 3. 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. **If the Contractor fails to comply with the Monthly Progress Update submission requirements the Commissioner reserves the right to withhold any or all contract payments.**

F. TOTAL FLOAT OWNERSHIP

- a. 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

- a. 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

- a. 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

- a. 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

- a. 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 meetings.
- 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 CONTRACTORS, General Contractor shall prepare and submit a Progress Schedule demonstrating responsible Contractor's plan to accelerate related work to achieve compliance with the Contract Times ("recovery schedule") for Engineer's acceptance.
2. When recovery schedule will affect another prime Contractor on the Project, input on proposed recovery schedule action from the responsible prime Contractors must be provided within 10 work days of such determination by the Engineer. Incorporate requirements of other prime Contractors into the recovery schedule to the extent applicable.
3. Submit recovery schedule within 10 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

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 prime 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. Prime Contractor's refusal, failure, or neglect to take appropriate recovery action, or General 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

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

1.6 BASIS OF PAYMENT

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

1. Payment will be made as follows:

- a. Upon submission of the Initial Baseline CPM Construction Schedule 20%
- b. Upon acceptance of the Baseline CPM Construction Schedule 20%
- c. The balance will be paid in equal monthly payments distributed over the contract. These payments will be contingent on the submission of acceptable monthly updates, 60%
- d. No additional payment over and above the lump sum price bid will be made for addition or deletion of work, delays, or any other reason whatsoever.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 013200

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals. In case of any conflicts or inconsistencies between this Section and Sections entitled "Notice to Bidders", "Instructions to Bidders", "Proposal Forms", "Conditions of Contract", "General Conditions" or "Form of Contract", the above-named sections shall govern.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Engineer's responsive action.
- B. Informational Submittals: Written information that does not require Engineer's approval. Submittals may be rejected for not complying with requirements.

1.3 SUBMITTAL PROCEDURES

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- B. Submittals Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
- C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal.
 - 1. Initial Review: Allow five days for initial review of each submittal. Allow additional time if processing must be delayed permitting coordination with

- subsequent submittals. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 2. If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Allow five days for processing each resubmittal.
 4. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.
- D. Identification: Place a permanent label or title block on each submittal for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space approximately 4 by 5 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
 3. Include the following information on label for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name and address of Engineer.
 - d. Name and address of Contractor.
 - e. Name and address of subcontractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Unique identifier, including revision number.
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Other necessary identification.
- E. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.
- F. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions of the Contract Documents, initial submittal may serve as final submittal.

1. Additional copies submitted for maintenance manuals will be marked with action taken and will be returned.
- G. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return submittals, without review, received from sources other than Contractor.
 1. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.
- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- I. Use for Construction: Use only final submittals with mark indicating action taken by Engineer in connection with construction.

PART 2 PRODUCTS

2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
 1. Number of Copies: Submit six copies of each submittal, unless otherwise indicated. Engineer will return three copies. Mark up and retain one returned copy as a Project Record Document.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Manufacturer's catalog cuts.
 - e. Wiring diagrams showing factory-installed wiring.

- f. Printed performance curves.
 - g. Operational range diagrams.
 - h. Compliance with recognized trade association standards.
 - i. Compliance with recognized testing agency standards.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
 - 1. Preparation: Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
 - f. Shop-work manufacturing instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Notation of coordination requirements.
 - j. Notation of dimensions established by field measurement.
 - 2. Wiring Diagrams: Differentiate between manufacturer-installed and field installed wiring.
 - 3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm).
- D. Coordination Drawings: Comply with requirements in Division 1 Section "Project Management and Coordination."
- E. Product Schedule or List: Prepare a written summary indicating types of products required for the Work and their intended location.
- F. Delegated-Design Submittal: Comply with requirements in Division 1 Section "Quality Requirements."

- G. Submittals Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation."
- H. Application for Payment: Comply with requirements in Division 1 Section "Payment Procedures."
- I. Schedule of Values: Comply with requirements in Division 1 Section "Payment Procedures."
- J. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design.

2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
 - 1. Number of Copies: Submit six copies of each submittal, unless otherwise indicated. Engineer will not return copies.
 - 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - 3. Test and Inspection Reports: Comply with requirements in Division 1 Section "Quality Requirements."
- B. Contractor's Construction Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation."
- C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of Engineers and owners, and other information specified.
- D. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements.
- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- F. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.

- G. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.
- H. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.
- I. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
- J. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- K. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.
- L. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- M. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.
- N. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 1 Section "Closeout Procedures."
- O. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
- P. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer.
- Q. Manufacturer's Field Reports: Prepare written information documenting factory authorized service representative's tests and inspections.

- R. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- S. Construction Photographs: Comply with requirements in Division 1 Section "Construction Progress Documentation."

PART 3 EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER'S ACTION

- A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken.
- C. Informational Submittals: Engineer will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- D. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION

SECTION 01356

SAFE AND HEALTHFUL WORKING CONDITIONS

PART 1 GENERAL

1.1 SUMMARY

- A. This section describes the requirements for safe and healthful working conditions as an integral part of the project construction.

1.2 DEFINITION

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

1.3 GENERAL REQUIREMENTS

- 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.
 - 1. Compliance with governmental requirements is mandated by law and considered only a minimum level of safety performance.
 - 2. All work shall also be performed in accordance with safe work practice, and contractor's Health and Safety Plan, as approved by the Construction Manager in writing.
- 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.
- 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.

1.5 SUBMITTALS

- A. The Contractor shall submit a Health and Safety Plan (HASP), prepared prior to the start of any construction for acceptance by the CM, in writing.
 - 1. The HASP shall be available to workers on site and be submitted to the Engineer and Owner at least two (2) weeks before the beginning of any field work.
 - 2. Copies of the plan shall be provided to the Contractors' insurers and their risk managers, if any, by the Contractor.
- 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/her direction.
- C. Documentation and/or personal references confirming the qualifications may also be required.
 - 1. The persons proposed as a safety person, safety professional, or safety representative(s), may be rejected by the Engineer for failure to have adequate qualifications or other cause.
- D. In addition, the Contractor shall submit the names, addresses, and telephone numbers of three (3) supervisory personnel who may be contacted in the event of an emergency occurring during non-working hours.

1.6 QUALIFICATIONS

- A. Safety Professional:
 - 1. Certification by the Board of Certified Safety Professional as a Certified Safety Professional.
 - 2. Minimum of five (5) years of professional safety management experience in the types of construction and conditions expected to be encountered on the site.
- B. Safety Person:
 - 1. Qualifications of the safety person must include a minimum of five (5) years of relevant construction experience, two (2) years of which are related to safety management.
- C. The Safety staff shall be completely experienced with OSHA requirements and knowledgeable of all applicable health and safety requirements of all governing laws, rules

and regulations as well as of good safety practice. The safety staff shall not include the project manager, engineer, or superintendent, or anyone else working on the project. The safety staff shall have no other duties except those directly related to safety.

PART 2 PRODUCTS

2.1 HEALTH AND SAFETY PLAN

- A. The Contractor shall commit to writing a specific site Health and Safety Plan before the start of any construction for acceptance by the Construction Manager.

2.2 ACCIDENT REPORTS

- A. The Contractor shall promptly (within the hour of the incident) report to the Construction Manager all accidents involving injury to personnel or damage to equipment and structures, investigate these accidents and prepare a preliminary report and submit within twenty-four (24) hours of the accident. The Contractor must submit a final accident report to the Construction Manager as follows:
 - 1. The summary report, due by the tenth (10th) day of the incident, 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 (1) day of receipt, and attach the final plan.
- B. In addition to the reports which the Contractor is required to file under the provisions of the Workman's Compensation Law, he/she shall submit to the Engineer on or before the tenth (10th) day of each month, a report giving the total force employed on his/her Contract in man-days during the previous calendar month, the number and character of all accidents resulting in loss of time or considered reportable 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 or safety person and the Contractor shall sign this audit report. The Engineer will review these reports for Contractor's compliance with the safety provisions of the Contract.

2.3 SAFETY AND RESCUE EQUIPMENT

- A. The Contractor shall have proper safety and rescue equipment, adequately maintained and readily available, for any foreseeable contingency. This equipment shall include such applicable items as: proper fire extinguishers, first aid supplies, safety ropes and harness, stretchers, water safety devices, oxygen breathing apparatus, resuscitators, gas detectors, oxygen deficiency indicators, combustible gas detectors, etc.
- B. This equipment shall be kept in a protected area and checked at scheduled intervals. A log shall be maintained indicating who checked the equipment, when it was checked, and that it was acceptable. This equipment log shall be updated monthly and be submitted with the monthly report. Equipment that requires calibration shall have copies of dated calibration certificates on site.
- C. Substitute safety and rescue equipment must be provided while primary equipment is being serviced or calibrated.

2.4 PROTECTIVE EQUIPMENT

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

PART 3 EXECUTION

3.1 SAFETY STAFF DUTIES

- A. The safety professional shall visit and audit all work areas as frequently as necessary (a minimum of once a week) and shall be available for consultation whenever necessary. The safety staff shall have full authority to implement and enforce the Health and Safety Plan to take immediate action to correct unsafe, hazardous, or unhealthful conditions.
- B. A member of the safety staff must be at the job site full time (a minimum of eight (8) hours per working day) whenever work is in progress. When multiple shift work is in progress, more than one (1) safety representative may be required. The safety staff shall as a minimum:
 - 1. Schedule safety training programs as required by law, the safety plan, and good safety practice. An outline of materials to be covered shall be provided with the safety plan. 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. In order to alert the workers "Safety First" signs should be posted, as ordered by the Engineer at no extra cost.
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/her 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 (1) work day of receipt of such reports.
8. Provide safety training and orientation to authorized visitors to ensure their safety while occupying the job site.
9. Perform all related tasks necessary to achieve the highest degree of safety that the nature of the work permits.

3.2 MEASUREMENT OF PAYMENT

- A. No separate payment for the article "Safe and Healthful Working Conditions" will be made. The costs of same will be included in the Lump Sum Bid.

END OF SECTION

SECTION 01400

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specified tests, inspections, and related actions do not limit Contractor's quality control procedures that facilitate compliance with the Contract Document requirements.
 - 2. Requirements for Contractor to provide quality-control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. See Divisions 2 through 16 Sections for specific test and inspection requirements.

1.2 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by Engineer.
- C. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

1.3 DELEGATED DESIGN

- A. Provide products and systems complying with all authorities having jurisdiction (As applicable.)
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

1.4 SUBMITTALS

- A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for fire suppression systems designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria required by the AHJ. Include list of codes, loads, and other factors used in performing these services.
- C. Reports: Prepare and submit certified written reports that include the following:
 - 1. Date of issue.
 - 2. Project title and number
 - 3. Name, address, and telephone number of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Ambient conditions at time of sample taking and testing and inspecting.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting and re-inspecting.
- D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents,

established for compliance with standards and regulations bearing on performance of the Work.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- C. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- D. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Testing Agency Qualifications: An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed.

1.6 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
- B. Contractor Responsibilities: Unless otherwise indicated, provide quality-control services specified and required by authorities having jurisdiction.
 - 1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ the same entity engaged by County, unless agreed to in writing by County.

2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.
- D. Re-testing/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including re-testing and re-inspecting, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents.
- E. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 3. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 4. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
 5. Do not perform any duties of Contractor.
- F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.

3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field-curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Sections of these Specifications. Restore patched areas and extend restoration into adjoining areas in a manner that eliminates evidence of patching.
 2. Comply with the Contract Document requirements for Division Sections.
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

SECTION 01420

REFERENCES

PART 1 GENERAL

1.1 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "approved," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Installer": Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.
- J. "Experienced": When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

- K. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.
- C. Conflicting Requirements: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.
1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.
- D. Copies of Standards: Each entity engaged in construction on Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.
- E. Abbreviations and Acronyms for Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list:

ADAAG	Americans with Disabilities Act (ADA)
CFR	Code of Federal Regulations
CRD	Handbook for Concrete and Cement
DOD	Department of Defense Specifications and Standards
FED-STD	Federal Standard (See FS) FS Federal Specification

FTMS	Federal Test Method Standard (See FS)
MILSPEC	Military Specification and Standards
UFAS	Uniform Federal Accessibility Standards

1.3 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale Research's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."
- B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list:

AA	Aluminum Association, Inc.(The)
AAADM	American Association of Automatic Door Manufacturers
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AAN	American Association of Nurserymen (See ANLA)
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists (The)
ABMA	American Bearing Manufacturers Association
ACI	American Concrete Institute/ACI International
ACPA	American Concrete Pipe Association
ADC	Air Diffusion Council
AEIC	Association of Edison Illuminating Companies, Inc. (The)
AFPA	American Forest & Paper Association (See AF&PA)
AF&PA	American Forest & Paper Association
AGA	American Gas Association
AGC	Associated General Contractors of America (The)

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AHA	American Hardboard Association
AHAM	Association of Home Appliance Manufacturers
AI	Asphalt Institute
AIA	American Institute of Architects (The)
AISC	American Institute of Steel Construction
ASI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALA	American Laminators Association (See LMA)
ALCA	Associated Landscape Contractors of America
ALSC	American Lumber Standard Committee
AMCA	Air Movement and Control Association International, Inc.
ANLA	American Nursery & Landscape Association (Formerly: AAN - American Association of Nurserymen)
ANSI	American National Standards Institute
AOSA	Association of Official Seed Analysts
APA	APA - The Engineered Wood Association
APA	Architectural Precast Association
API	American Petroleum Institute
ARI	Air-Conditioning & Refrigeration Institute
ASCA	Architectural Spray Coaters Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	ASME International (The American Society of Mechanical Engineers International)
ASSE	American Society of Sanitary Engineering

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ASTM	American Society for Testing and Materials
AWCI	AWCI International (Association of the Wall and Ceiling Industries International)
AWCMA	American Window Covering Manufacturers Association (See WCMA)
AWI	Architectural Woodwork Institute
AWPA	American Wood-Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Industry Association (The)
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International)
CCC	Carpet Cushion Council
CCFSS	Center for Cold-Formed Steel Structures
CDA	Copper Development Association Inc.
CEA	Canadian Electricity Association
CFFA	Chemical Fabrics & Film Association, Inc.
CGA	Compressed Gas Association
CGSB	Canadian General Standards Board
CIMA	Cellulose Insulation Manufacturers Association
CISCA	Ceilings & Interior Systems Construction Association
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturers Institute
CPA	Composite Panel Association (Formerly: National Particleboard Association)
CPPA	Corrugated Polyethylene Pipe Association

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CRI	Carpet & Rug Institute (The)
CRSI	Concrete Reinforcing Steel Institute
CSA	CSA International (Formerly: IAS - International Approval Services)
CSI	Construction Specifications Institute (The)
CSSB	Cedar Shake & Shingle Bureau
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute)
DHI	Door and Hardware Institute
EIA/TIA	Electronic Industries Alliance/Telecommunications Industry Association
EIMA	EIFS Industry Members Association
EJMA	Expansion Joint Manufacturers Association, Inc.
FCI	Fluid Controls Institute
FGMA	Flat Glass Marketing Association (See GANA)
FM	Factory Mutual System (See FMG)
FMG	FM Global (Formerly: FM - Factory Mutual System)
GA	Gypsum Association
GANA	Glass Association of North America (Formerly: FGMA - Flat Glass Marketing Association)
GRI	Geosynthetic Research Institute
GTA	Glass Tempering Division of Glass Association of North America (See GANA)
HI	Hydraulic Institute
HI	Hydronics Institute
HMMA	Hollow Metal Manufacturers Association (See NAAMM)
HPVA	Hardwood Plywood & Veneer Association

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HPW	H. P. White Laboratory, Inc.
IAS	International Approval Services (See CSA International)
ICEA	Insulated Cable Engineers Association, Inc.
ICRI	International Concrete Repair Institute (The)
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The)
IESNA	Illuminating Engineering Society of North America
IGCC	Insulating Glass Certification Council
ILI	Indiana Limestone Institute of America, Inc.
IRI	Industrial Risk Insurers
ITS	Intertek Testing Services
IWS	Insect Screening Weavers Association (Now defunct)
KCMA	Kitchen Cabinet Manufacturers Association
LGSI	Light Gage Structural Institute
LMA	Laminating Materials Association (Formerly: ALA - American Laminators Association)
LPI	Lightning Protection Institute
LSGA	Laminated Safety Glass Association (See GANA)
MBMA	Metal Building Manufacturers Association
MCA	Metal Construction Association
MFMA	Maple Flooring Manufacturers Association
MFMA	Metal Framing Manufacturers Association
MGPHO	Medical Gas Professional Healthcare Organization, Inc.
MHIA	Material Handling Industry of America
MIA	Marble Institute of America

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ML/SFA	Metal Lath/Steel Framing Association (See SSMA)
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
NAAMM	National Association of Architectural Metal Manufacturers
NAAMM	North American Association of Mirror Manufacturers (See GANA)
NACE	NACE International (National Association of Corrosion Engineers International)
NAIMA	North American Insulation Manufacturers Association (The)
NAMI	National Accreditation and Management Institute, Inc.
NAPM	National Association of Photographic Manufacturers (See PIMA)
NBGQA	National Building Granite Quarries Association, Inc.
NCMA	National Concrete Masonry Association
NCPI	National Clay Pipe Institute
NCTA	National Cable Television Association
NEBB	National Environmental Balancing Bureau
NECA	National Electrical Contractors Association
NeLMA	Northeastern Lumber Manufacturers' Association
NEMA	National Electrical Manufacturers Association
NETA	Inter-National Electrical Testing Association
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council
NGA	National Glass Association
NHLA	National Hardwood Lumber Association
NLGA	National Lumber Grades Authority
NOFMA	National Oak Flooring Manufacturers Association

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NPA	National Particleboard Association (See CPA)
NRCA	National Roofing Contractors Association
NRMCA	National Ready Mixed Concrete Association
NSA	National Stone Association
NSF	NSF International (National Sanitation Foundation International)
NTMA	National Terrazzo and Mosaic Association, Inc.
NWWDA	National Wood Window and Door Association (See WDMA)
PCI	Precast/Prestressed Concrete Institute
PDCA	Painting and Decorating Contractors of America
PDI	Plumbing & Drainage Institute
PGI	PVC Geomembrane Institute
PIMA	Photographic & Imaging Manufacturers Association (Formerly: NAPM - National Association of Photographic Manufacturers)
RCSC	Research Council on Structural Connections
RFCI	Resilient Floor Covering Institute
RIS	Redwood Inspection Service
RMA	Rubber Manufacturers Association
SAE	SAE International
SDI	Steel Deck Institute
SDI	Steel Door Institute
SEFA	Scientific Equipment and Furniture Association
SGCC	Safety Glazing Certification Council
SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute
SMA	Screen Manufacturers Association

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SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division)
SPI	The Society of the Plastics Industry
SPIB	Southern Pine Inspection Bureau (The)
SPI/SPFD	The Society of the Plastics Industry Spray Polyurethane Foam Division (See SPFA)
SPRI	SPRI (Single Ply Roofing Institute)
SSINA	Specialty Steel Industry of North America
SSMA	Steel Stud Manufacturers Association (Formerly: ML/SFA - Metal Lath/Steel Framing Association)
SSPC	The Society for Protective Coatings
STI	Steel Tank Institute
SWI	Steel Window Institute
SWRI	Sealant, Waterproofing, and Restoration Institute
TCA	Tile Council of America, Inc.
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance
TPI	Truss Plate Institute
TPI	Turfgrass Producers International
UFAC	Upholstered Furniture Action Council
UL	Underwriters Laboratories Inc.
UNI	Uni-Bell PVC Pipe Association
USITT	United States Institute for Theatre Technology, Inc.
USP	U.S. Pharmacopeia
WASTEC	Waste Equipment Technology Association

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WCLIB	West Coast Lumber Inspection Bureau
WCMA	Window Covering Manufacturers Association (Formerly: AWCMA - American Window Covering Manufacturers Association)
WDMA	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association)
WIC	Woodwork Institute of California
WMMPA	Wood Molding & Millwork Producers Association
WWPA	Western Wood Products Association

- C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list:

BOCA	BOCA International, Inc.
CABO	Council of American Building Officials (See ICC)
IAPMO	International Association of Plumbing and Mechanical Officials (The)
ICBO	International Conference of Building Officials
ICC	International Code Council (Formerly: CABO - Council of American Building Officials)
SBCCI	Southern Building Code Congress International, Inc.

- D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list:

CE	Army Corps of Engineers
CPSC	Consumer Product Safety Commission
DOC	Department of Commerce
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FCC	Federal Communications Commission

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FDA	Food and Drug Administration
GSA	General Services Administration
HUD	Department of Housing and Urban Development
LBL	Lawrence Berkeley Laboratory (See LBNL)
LBNL	Lawrence Berkeley National Laboratory
NCHRP	National Cooperative Highway Research Program (See TRB)
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety & Health Administration
RUS	Rural Utilities Service (See USDA)
TRB	Transportation Research Board
USDA	Department of Agriculture
USPS	Postal Service

- E. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list:

CAPU	(See CPUC)
CBHF	State of California, Department of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation
CPUC	California Public Utilities Commission
TFS	Texas Forest Service Forest Products Laboratory
NYS	State of New York, Department of Building Codes, Department of Consumer Affairs Bureau of Home Furnishings and Thermal Insulation

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

References

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END OF SECTION

SECTION 01495

SPILL PREVENTION AND CONTROL

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. This section covers the Contractor's responsibilities with respect for spill prevention and control.

1.2 APPLICABLE REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to by basic designation only and shall be the latest published versions.
 - 1. United States Environmental Protection Agency (USEPA): EPA/625/6-B5/006, Remedial Action at Waste Disposal sites
 - 2. Code of Federal Regulations (CFR): 40 CFR Part 300, National Oil and Hazardous Substances Pollution Contingency Plan 40 CFR, Protection of Environment
 - 3. American Society for Testing and Materials (ASTM): ASTM E119, Fire Resistance Directory

1.3 SUBMITTALS

- A. Spill Prevention and Control Plan shall be provided to the Construction Manager, upon request, in accordance with Section 01330: SUBMITTALS

1.4 GENERAL REQUIREMENTS

- A. The Contractor shall prepare and implement a Spill Prevention and Control Plan and maintain appropriate containment and/or diversionary structure, 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 procedure performed to ensure compliance.
- B. Laws and Regulations: The Contractor shall not pollute any area with any manmade or natural harmful materials. It is the sole responsibility of the Contractor to investigate and comply with all applicable federal, State, County, and municipal laws and regulations concerning the Spill Prevention and Control Plan.
- C. A Project Telephone Directory shall be incorporated into the plan.
- D. Written Discussions: In addition to the minimal prevention standards listed, the Plan shall include a complete discussion of conformance with the following applicable guidelines,

other effective spill prevention and containment procedures, or if more stringent, with the State rules, regulations and guidelines.

1. Facility drainage
 2. Bulk storage
 3. Facility transfer operations, pumping, and conveying materials
 4. Truck loading/unloading rack
- E. Design and Specifications: The Contractor shall provide a Spill Prevention and Control Plan with the following designs and specifications:
1. Appropriate containment and/or diversionary structures or equipment to prevent discharge of materials to the environment
 2. Dikes sufficiently impervious to contain spill materials
 3. Curbing
 4. Culverts, gutters, or other drainage systems
 5. Weirs, booms, or other barriers
 6. Sorbent materials
 7. Curbing drip pans
 8. Sumps and collection systems
- F. Inspections and Records: Inspections required by this “Scope of Work” shall be in accordance with written procedures developed for the facility by 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 Construction Manager for final closeout.
- G. Facility Lighting: Facility lighting shall be commensurate with the type and location of the facility. Consideration shall be given to:
1. Discovery of spills occurring during hours of darkness, both by operating personnel, if present, and by non-operating personnel such as security personnel, the general public, local police, etc.
 2. Prevention of spills occurring through acts of vandalism.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

- A. If materials are released, the Contractor shall provide a written description of the event, corrective action taken, and plans for preventing a recurrence, as well as a written commitment of manpower, equipment, and materials required to expedite control and removal of any harmful quantity of materials released.
- B. The Contractor shall notify the NYSDEC within two (2) hours of the release or spill. The Contractor shall notify the DEC hotline at 1-800-457-7362.

3.2 TRAINING

- A. Personnel Training and Spill Prevention Procedures: The Contractor shall be responsible for properly instructing his/her 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: Evacuation Routes shall be marked on the project site.

3.3 TESTING

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

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes requirements for temporary facilities and controls, including temporary utilities, support facilities, and security and protection facilities.

1.2 GENERAL

- A. Contractor is responsible for installing and maintaining all temporary facilities and controls required to perform all work.

1.3 USE CHARGES

- A. General: Cost or use charges for temporary facilities are not chargeable to Owner or Engineer and shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, County forces, testing and inspecting agencies and personnel of authorities having jurisdiction.

1.4 SUBMITTALS

- A. Temporary Utility Reports: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

1.5 QUALITY ASSURANCE

- A. Standards: Comply with ANSI A10.6, NECA's "Temporary Electrical Facilities," and NFPA 241.
 - 1. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

- A. Temporary Utilities: At earliest feasible time, when acceptable to County, change over from use of temporary service to use of permanent service.
 - 1. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each

permanent service during its use as a construction facility before County acceptance, regardless of previously assigned responsibilities.

- B. Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the Work:
 - 1. Keep temporary services and facilities clean and neat.
 - 2. Relocate temporary services and facilities as required by progress of the Work.

PART 2 PRODUCTS

2.1 MATERIALS

- A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Engineer. Provide materials suitable for use intended.
- B. Pavement: Comply with Division 2 pavement Sections.
- C. Tarpaulins: Fire-resistive labeled with flame-spread rating of 15 or less.
- D. Water: Potable.

2.2 EQUIPMENT

- A. Fire Extinguishers: Hand carried, portable, UL rated. Provide class and extinguishing agent as indicated or a combination of extinguishers of NFPA-recommended classes for exposures.
 - 1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.
- B. Self-Contained Toilet Units: Single-occupant units of chemical, aerated recirculation, or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.
- C. Electrical Outlets: Properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-V plugs into higher-voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities as directed by the County where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.
- B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 - 1. Locate sanitary facilities, and other temporary construction and support facilities for easy access, and as indicated by the Owners.
 - 2. Provide non-combustible construction for items located within construction area or within 30 feet (9 m) of building lines, if approved by the Owner. Comply with NFPA 241.
 - 3. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use owners' facilities, under conditions acceptable to Owner.

3.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid using tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from persons or firms near Project site.
- B. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from construction damage. Protect tree root systems from damage, flooding, and erosion.
- C. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erecting structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and public of possible hazard. Where appropriate and needed, provide lighting, including flashing red or amber lights.

3.4 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage caused by freezing temperatures and similar elements.

1. Maintain markers for underground lines. Protect from damage during excavation operations.
- C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are the property of Contractor. Owner reserves right to take possession of Project identification signs.
 2. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with other division requirements.

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for selecting products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

1.2 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.
- D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to the County.
- E. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.3 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
 - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
 - 5. Store products to allow for inspection and measurement of quantity or counting of units.
 - 6. Store materials in a manner that will not endanger Project structure.
 - 7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - 8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 9. Protect stored products from damage.

1.5 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: Forms are included with the Specifications. Prepare a written document using appropriate form properly executed.
 3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 1 Section "Closeout Procedures."

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Engineer will make selection.
 5. Where products are accompanied by the term "match sample," sample to be matched is Engineer's.
 6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
- B. Product Selection Procedures: Procedures for product selection include the following:
1. Product: Where Specification paragraphs or subparagraphs titled "Product" name a single product and manufacturer, provide the product named.
 - a. Substitutions may be considered, unless otherwise indicated.
 2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled "Manufacturer" or "Source" name single manufacturers or sources, provide a

product by the manufacturer or from the source named that complies with requirements.

a. Substitutions may be considered, unless otherwise indicated.

3. Products: Where Specification paragraphs or subparagraphs titled "Products" introduce a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.

a. Substitutions may be considered, unless otherwise indicated.

4. Manufacturers: Where Specification paragraphs or subparagraphs titled "Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.

a. Substitutions may be considered, unless otherwise indicated.

5. Available Products: Where Specification paragraphs or subparagraphs titled "Available Products" introduce a list of names of both products and manufacturers, provide one of the products listed or another product that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

6. Available Manufacturers: Where Specification paragraphs or subparagraphs titled "Available Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed or another manufacturer that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

7. Basis-of-Design Products: Where Specification paragraphs or subparagraphs titled "Basis-of-Design Product" are included and also introduce or refer to a list of manufacturers' names, provide either the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

a. Substitutions may be considered, unless otherwise indicated.

8. Visual Matching Specification: Where Specifications require matching an established Sample, select a product (and manufacturer) that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches satisfactorily.

a. If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents on "substitutions" for selection of a matching product.

9. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product (and manufacturer) that complies with other specified requirements.
 - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, or texture from manufacturer's product line that does not include premium items.
 - b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Where products or manufacturers are specified by name, submit the following, in addition to other required submittals, to obtain approval of an unnamed product:
 1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners, if requested.
 5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01650

MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

- A. Specific requirements pertaining to materials and equipment specified elsewhere are additional to the provisions of this Section.

1.02 PRODUCT LABELS

- A. When materials or equipment are specified to conform to ASTM, Federal or other reference specifications, the materials delivered to the site shall bear the manufacturer's printed labels stating that the materials meet the requirements of such referenced specifications.

1.03 TRANSPORTATION AND HANDLING

- A. Deliver factory packaged materials and equipment in the manufacturer's original containers.
- B. Transport and handle materials and equipment in such a manner as to prevent their damage.
- C. Arrange for delivery of materials and equipment during the hours of the day established by the County.
- D. Have workers available to receive and unload materials and equipment delivered to the site. Do not deliver, or have delivered, any materials and equipment to the site unless such forces are available.
- E. County personnel are not authorized to sign for receipt of Contractor's material or equipment.

1.04 STORAGE AND PROTECTION

- A. Neatly pile, store, protect, and secure materials and equipment in locations where directed.
- B. Protect materials and equipment subject to damage by temperature or other weather conditions.
- C. Do not store volatile liquids in a County building.

END OF SECTION

SECTION 01731

CUTTING AND PATCHING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes procedural requirements for cutting and patching.
- B. See other Divisions Sections for other requirements and limitations applicable to cutting and patching.

1.2 SUBMITTALS

- A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
 - 1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
 - 2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
 - 3. Products: List products to be used and firms or entities that will perform the Work.
 - 4. Dates: Indicate when cutting and patching will be performed.
 - 5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
 - 6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
 - 7. Engineer's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.3 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

- C. Miscellaneous Elements: Do not cut and patch elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
- D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

1.4 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections of these Specifications.
- B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
 - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.

- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to minimize or avoid interruption of services to occupied areas.

3.3 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete, Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 6. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing-up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
4. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

END OF SECTION

SECTION 01732

SELECTIVE DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes demolition and removal of the following:
 - 1. Selected site elements.
 - 2. Repair procedures for selective demolition operations.

1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to County ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain County's property, demolished materials shall become Contractor's property and shall be removed from Project site.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with Authorities Having Jurisdiction notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.5 PROJECT CONDITIONS

- A. County assumes no responsibility for condition of areas to be selectively demolished.
 - 1. Conditions existing at time of inspection for bidding purpose will be maintained by County as far as practical.

- B. Hazardous Materials: Hazardous materials including contaminated soils may be present in areas to be selectively demolished.
- C. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.6 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 PRODUCTS

2.1 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
 - 1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 - 2. Use materials whose installed performance equals or surpasses that of existing materials.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Engineer.

3.2 UTILITY SERVICES

- A. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.
- B. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.
- C. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.
 - 1. Arrange to shut off indicated utilities with utility companies.
 - 2. If utility services are required to be removed, relocated, or abandoned, provide temporary utilities before proceeding with selective demolition that bypass area of selective demolition and that maintain continuity of service to other parts of building.
 - 3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
- D. Utility Requirements: Refer to Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Protect existing site improvements, appurtenances, and landscaping to remain.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent facilities to remain.
- C. Temporary Enclosures: Provide temporary enclosures for protection of existing construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.
- D. Temporary Shoring: Provide and maintain exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of construction to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

3.4 POLLUTION CONTROLS

- A. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.

- B. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- C. Cleaning: Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.5 SELECTIVE DEMOLITION

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations.
 - 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction.
 - 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
 - 4. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting structures.
- B. Removed and Salvaged Items:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to County.
 - 4. Protect items from damage during transport and storage.
- C. Removed and Reinstalled Items:
 - 1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 - 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 - 3. Protect items from damage during transport and storage.

4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 PATCHING AND REPAIRS

- A. General: Promptly repair damage to adjacent construction caused by selective demolition operations.
- B. Patching: Comply with Division 1 Section "Cutting and Patching."
- C. Repairs: Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
 1. Completely fill holes and depressions in existing masonry walls that are to remain with an approved masonry patching material applied according to manufacturer's written recommendations.
- D. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off County property and legally dispose of them.

END OF SECTION

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout. In case of any conflicts or inconsistencies between this Section and Sections entitled “Notice to Bidders”, “Instructions to Bidders”, “Proposal Forms”, “Conditions of Contract”, “General Conditions” or “Form of Contract”, the above-named sections shall govern. This Section includes, but is not limited to, the following:
1. Inspection procedures.
 2. Project Record Documents
 3. Operation and maintenance manuals.
 4. Warranties.
 5. Instruction of Owner's personnel.
 6. Final cleaning.

1.2 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 2. Advise County of pending insurance changeover requirements.
 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Obtain and submit releases permitting County unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs damage or settlement surveys, and similar final record information.

6. Deliver tools, spare parts, extra materials, and similar items to location designated by County. Label with manufacturer's name and model number where applicable.
 7. Deliver keys to County. Advise County personnel of changeover in security provisions.
 8. Complete startup testing of systems.
 9. Submit testing records, and certificates of approval by Authorities having jurisdiction.
 10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 11. Advise County of changeover in utilities.
 12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
 13. Complete final cleaning requirements.
 14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.3 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
1. Submit a final Application for Payment.
 2. Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: Submit six copies of list. Include name and identification of each area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. List shall be approved by Engineer.

1.5 PROJECT RECORD DOCUMENTS

- A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.
- B. Record Drawings: Maintain and submit two sets of blue- or black-line white prints of Contract Drawings and Shop Drawings.
1. Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
 - b. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 3. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.

4. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.
 5. Indicate exact locations of features which were indicated schematically on the plans.
- C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Note related Change Orders and Record Drawings, where applicable.
- D. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.6 OPERATION AND MAINTENANCE MANUALS

- A. Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:
1. Operation Data: Include emergency instructions and procedures, system and equipment descriptions, operating procedures, and sequence of operations.
 2. Maintenance Data: Include manufacturer's information, list of spare parts, maintenance procedures, maintenance and service schedules for preventive and routine maintenance, and copies of warranties and bonds.
- B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents.

1.7 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 - 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8 1/2-by-11-inch (115-by-280-mm) paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 EXECUTION

3.1 DEMONSTRATION AND TRAINING

- A. Instruction: Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Provide instructors experienced in operation and maintenance procedures.
 - 2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
 - 3. Schedule training with Owner, through Engineer, with at least seven days' advance notice.
 - 4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content.

- B. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections. For each training module, develop a learning objective and teaching outline.
 - 1. Include instruction for system design and operational philosophy, review of documentation, operations, adjustments, troubleshooting, maintenance, and repair.

3.2 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - f. Sweep concrete floors broom-clean in unoccupied spaces.
 - g. Remove labels that are not permanent.
 - h. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.

- i. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint, and other foreign substances.
 - j. Replace parts subject to unusual operating conditions.
 - k. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs.
 - l. Leave Project clean and ready for occupancy.
- C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on County property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION

**PHOTOGRAPHIC DOCUMENTATION
SECTION 013233**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Periodic construction photographs.
- B. See Division 01 Section "Closeout Procedures" for submitting digital media as Project Record Documents at Project closeout.
- C. See Division 01 Section "Demonstration and Training" for submitting videotapes of demonstration of equipment and training of Owner's personnel.

1.03 SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same label information as corresponding set of photographs.
- B. Construction Photographs: Provide photographs in number and frequency in accordance with GC-37 of the General Conditions.
- C. Photographic Prints: Submit two prints of each photographic view within three days of taking photographs.
 - 1. Format: 8-by-10-inch (203-by-254-mm) smooth-surface matte prints on single-weight commercial-grade photographic paper, enclosed back to back in clear plastic sleeves that are punched for standard 3-ring binder.
 - 2. Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:
 - a. Name of Project.
 - b. Name and address of photographer.

- c. Owner's name.
 - d. Name of Contractor.
 - e. Date photograph was taken if not date stamped by camera.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - g. Unique sequential identifier.
3. Digital Images: Submit a complete set of digital image electronic files with each submittal of prints on CD-ROM. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as the sensor, uncropped.

1.04 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

1.05 COORDINATION

- A. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested, including access to Project site and use of temporary facilities, including temporary lighting required to produce clear, well-lit photographs without obscuring shadows.

1.06 USAGE RIGHTS

- A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 PRODUCTS

2.01 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in uncompressed PNG, JPG, or JPEG format, produced by a digital camera with minimum sensor size of 4.0 megapixels, and at an image resolution of not less than 1024 by 768 pixels.

PART 3 EXECUTION

3.01 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified commercial photographer to take construction photographs.
- B. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
 - 1. Date and Time: Include date and time in filename for each image.
 - 2. Field Office Images: Maintain one set of images on CD-ROM in the field office at Project site, available at all times for reference. Identify images same as for those submitted to Architect.
- D. Preconstruction Photographs: Before commencement of demolition, take digital photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Construction Manager.
 - 1. Flag construction limits before taking construction photographs.
 - 2. Take eight photographs to show existing conditions adjacent to property before starting the Work.
 - 3. Take eight photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
- E. Periodic Construction Photographs: Take at least 12 digital photographs weekly, with timing each month adjusted to coincide with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
- F. Provide photos to highlight the implemented construction IAQ practices in accordance with the submittal requirements in Division 01 Section "Indoor Air Quality (IAQ) Management."
- G. Additional Photographs: Architect may issue requests for additional photographs, in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
 - 1. Three days' notice will be given, where feasible.

2. In emergency situations, take additional photographs within 24 hours of request.
3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Special events planned at Project site.
 - b. Immediate follow-up when on-site events result in construction damage or losses.
 - c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - d. Substantial Completion of a major phase or component of the Work.
 - e. Extra record photographs at time of final acceptance.
 - f. Owner's request for special publicity photographs.

END OF SECTION 01 32 33

EXECUTION
SECTION 017300

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. Installation of the Work.
 - 4. Coordination of Owner-installed products.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
 - 8. Correction of the Work.
- B. Related Requirements:
 - 1. Division 01 Section "Summary" for limits on use of Project site.
 - 2. Division 01 Section "Submittal Procedures" for submitting surveys.
 - 3. Division 01 Section "Cutting and Patching" for cutting and patching of building elements during construction.
 - 4. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.
 - 5. Division 02 Section "Selective Structure Demolition" for demolition and removal of selected portions of the building.

6. Division 07 Section "Penetration Firestopping" for patching penetrations in fire-rated construction.

1.03 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Certificates: Submit certificate signed by professional engineer certifying that location and elevation of improvements comply with requirements.
- C. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- D. Certified Surveys: Submit two copies signed by professional engineer.
- E. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - 1. Description of the Work.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines,

services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Division 01 Section "Project Management and Coordination."

3.03 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. General: Engage a professional engineer to lay out the Work using accepted surveying practices.
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish limits on use of Project site.
 - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 4. Inform installers of lines and levels to which they must comply.
 - 5. Check the location, level and plumb, of every major element as the Work progresses.
 - 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.04 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

3.05 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.

2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 2. Allow for building movement, including thermal expansion and contraction.
 3. Coordinate installation of anchorages. 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.

- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.06 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
 - 1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 - 2. Pre-installation Conferences: Include Owner's construction personnel at pre-installation conferences covering portions of the Work that are to receive Owner's work. Attend pre-installation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.07 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 - 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

- B. Site: Maintain Project site free of waste materials and debris. Be responsible for the following:
 - 1. General site maintenance including mowing of lawns and snow removal.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Division 01 Section "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.08 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Division 01 Section "General Commissioning Requirements."

- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Division 01 Section "Quality Requirements."

3.09 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching".
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01 73 00

CONSTRUCTION WASTE MANAGEMENT SECTION 017419

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Sections include the following:
 - 1. Division 01 Section "Temporary Facilities and Controls" for environmental protection measures during construction, and location of waste containers at Project site.
 - 2. Division 02 Section "Selective Structure Demolition" for disposition of hazardous waste.

1.03 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.04 PERFORMANCE GOALS

- A. General: Develop waste management plan that results in end-of-Project rates for salvage/recycling of 50 percent by weight of total waste generated by the Work.

1.05 SUBMITTALS

- A. Waste Management Plan: Submit 3 copies of plan within 7 days of date established for commencement of the Work. An example of a Waste Management Plan can be found at www.nyc.gov/html/ddc/downloads/pdf/wastemgmt.pdf.
- B. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- C. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- D. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.06 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

1.07 WASTE MANAGEMENT PLAN

- A. General: Develop plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Include separate sections in plan for demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.
- D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:
1. Total quantity of waste.
 2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
 3. Total cost of disposal (with no waste management).
 4. Revenue from salvaged materials.
 5. Revenue from recycled materials.
 6. Savings in hauling and tipping fees by donating materials.
 7. Savings in hauling and tipping fees that are avoided.

8. Handling and transportation costs. Include cost of collection containers for each type of waste.
9. Net additional cost or net savings from waste management plan.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PLAN IMPLEMENTATION

- A. General: Implement waste management plan as approved by Architect. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 1. Comply with Division 01 Section "Temporary Facilities and Controls" for operation, termination, and removal requirements.
- B. Waste Management Coordinator: The Job Superintendent or other person designated by the Contractor shall serve as waste management coordinator, responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
 1. Distribute waste management plan to everyone concerned within three days of submittal return.
 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
 2. Comply with Division 01 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.02 SALVAGING DEMOLITION WASTE

- A. Salvaged Items for Reuse in the Work:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until installation.
 - 4. Protect items from damage during transport and storage.
 - 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- B. Salvaged Items for Sale and Donation: Not permitted on Project site.
- C. Salvaged Items for Owner's Use:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area off-site.
 - 5. Protect items from damage during transport and storage.
- D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

3.03 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.
- C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

3.04 RECYCLING DEMOLITION WASTE

- A. Metals: Separate metals by type.

3.05 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION 01 74 19

**OPERATION AND MAINTENANCE DATA
SECTION 017823**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation manuals for systems, subsystems, and equipment.
 - 2. Maintenance manuals for the care and maintenance of products, materials, and finishes, and systems and equipment.
- B. Related Sections include the following:
 - 1. Division 01 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 2. Division 01 Section "Closeout Procedures" for submitting operation and maintenance manuals.
 - 3. Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.03 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.04 SUBMITTALS

- A. Final Submittal: Submit one copy of each manual in final form at least 15 days before final inspection. Architect will return copy with comments within 15 days after final inspection.
 - 1. Correct or modify each manual to comply with Architect's comments. Submit three (3) copies of each corrected manual within 15 days of receipt of Architect's comments.

1.05 COORDINATION

- A. Where operation and maintenance documentation include information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 PRODUCTS

2.01 MANUALS, GENERAL

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name, address, and telephone number of Contractor.
 - 4. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
 - 1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (216-by-279-mm) paper; with clear plastic sleeve on spine to hold

label describing contents and with pockets inside covers to hold folded oversize sheets.

- a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
 4. Supplementary Text: Prepared on 8-1/2-by-11-inch (216-by-279-mm) white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.02 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 1. System, subsystem, and equipment descriptions.
 2. Performance and design criteria if Contractor is delegated design responsibility.
 3. Operating standards.

4. Operating procedures.
 5. Wiring diagrams.
 6. Control diagrams.
 7. Piped system diagrams.
 8. Precautions against improper use.
 9. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
1. Product name and model number.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
 2. Routine and normal operating instructions.
 3. Regulation and control procedures.
 4. Instructions on stopping.
 5. Normal shutdown instructions.
 6. Seasonal and weekend operating instructions.
 7. Required sequences for electric or electronic systems.
 8. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.03 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

2.04 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard printed maintenance instructions and bulletins.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Troubleshooting guide.
 - 2. Precautions against improper maintenance.
 - 3. Demonstration and training videotape, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 EXECUTION

3.01 MANUAL PREPARATION

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- D. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
 1. Do not use original Project Record Documents as part of operation and maintenance manuals.
 2. Comply with requirements of newly prepared Record Drawings in Division 01 Section "Project Record Documents".
- E. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

PROJECT RECORD DOCUMENTS
SECTION 017839

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
- B. Related Sections include the following:
 - 1. Division 01 Section "Project Management and Coordination" for submitting and distributing electronic project record documents.
 - 2. Electronic Data Release Form, following Division 01 Section "Submittal Procedures" for the form that must be completed before CAD files will be released to the Contractor.
 - 3. Division 01 Section "Closeout Procedures" for general closeout procedures.
 - 4. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 5. Divisions 02 through 49 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.03 SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit copies of Record Drawings as follows:
 - a. Initial Submittal: Submit one set of marked-up Record Prints. Architect will initial and date each drawing and mark whether general scope of changes, additional information recorded, and quality of drafting is acceptable. Architect will return prints for organizing into sets, printing, binding, and final submittal.

- b. Final Submittal: Submit three sets of marked-up Record Prints. Print each Drawing, whether or not changes and additional information were recorded.
 - c. Final Submittal: Submit one set of marked-up Record Prints, one set of Record CAD Drawing files, one set of Record CAD Drawing plots, and three copies printed from record plots. Plot and print each Drawing, whether or not changes and additional information were recorded. Include above noted files on one (1) Electronic Media: CD-R.
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.

PART 2 PRODUCTS

2.01 RECORD DRAWINGS

- A. Record Prints: Maintain one set of blue-or black-line white prints of the Contract Drawings and Shop Drawings.
 - 1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.

- g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - 3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
 - 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 - 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Newly-Prepared Record Drawings: Prepare new Drawings instead of preparing Record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
- 1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
 - 2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared Record Drawings into Record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
- 1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 - 2. Record Transparencies: Organize into unbound sets matching Record Prints. Place transparencies in durable tube-type drawing containers with

end caps. Mark end cap of each container with identification. If container does not include a complete set, identify Drawings included.

3. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

2.02 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
 5. Note related Change Orders and Record Drawings where applicable.

2.03 ELECTRONIC DOCUMENTS RECORD SUBMITTALS

- A. Provide copies of all electronic documents issued or transmitted during the course of construction, recorded on DVD-ROM. These documents shall include all submittals, RFIs, payment requests, progress schedules and charts, coordination drawings and models, minutes of meetings, records of telephone calls, e-mails, letters, and transmittals generated by the Construction Manager, all of the contractors, subcontractors, and suppliers, the Architect and the Architect's consultants, and the Owner and the Owner's consultants and other advisors. Only those documents that were distributed using the Construction Manager's project management software or project-specific web site need be provided on DVD-ROM.

2.04 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 EXECUTION

3.01 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

END OF SECTION 01 78 39

DEMONSTRATION AND TRAINING SECTION 017900

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training videos.
- B. See Divisions 02 through 49 Sections for specific requirements for demonstration and training for products in those Sections.

1.03 SUBMITTALS

- A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
- B. Demonstration and Training Videotapes: Submit two copies within seven days of end of each training module.

1.04 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 PRODUCTS

2.01 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include system and equipment descriptions, operating standards, regulatory requirements, equipment function, operating characteristics, limiting conditions, and performance curves.
 - 2. Documentation: Review emergency, operations, and maintenance manuals; Project Record Documents; identification systems; warranties and bonds; and maintenance service agreements.
 - 3. Emergencies: Include instructions on stopping; shutdown instructions; operating instructions for conditions outside normal operating limits; instructions on meaning of warnings, trouble indications, and error messages; and required sequences for electric or electronic systems.
 - 4. Operations: Include startup, break-in, control, and safety procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; operating procedures for emergencies and equipment failure; and required sequences for electric or electronic systems.
 - 5. Adjustments: Include alignments and checking, noise, vibration, economy, and efficiency adjustments.
 - 6. Troubleshooting: Include diagnostic instructions and test and inspection procedures.

7. Maintenance: Include inspection procedures, types of cleaning agents, methods of cleaning, procedures for preventive and routine maintenance, and instruction on use of special tools.
8. Repairs: Include diagnosis, repair, and disassembly instructions; instructions for identifying parts; and review of spare parts needed for operation and maintenance.

PART 3 EXECUTION

3.01 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 1. Owner will furnish an instructor to describe Owner's operational philosophy.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 1. Schedule training with Owner with at least seven days' advance notice.
- D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.

3.02 DEMONSTRATION AND TRAINING VIDEOS

- A. General: Engage a qualified commercial photographer to record demonstration and training videos. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Video Format: Provide high-quality color DVDs in full-size DVD cases with descriptive labels on both the discs and the cases.
- C. Narration: Describe scenes on video by dubbing audio narration off-site after video is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.

END OF SECTION 01 79 00

**LIMITS FOR VOC CONTENTS FOR ADHESIVES, SEALANTS,
PAINTS, AND COATINGS
SECTION 018115**

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. This Section defines the volatile organic compound (VOC) content limits for the adhesives, sealants, paints and architectural coatings used in the project. Chemical component limitations are also defined for some categories of paint and primer.

1.03 RELATED SECTIONS

- A. Specifications in Divisions 02 through 49 with field-applied adhesive, sealant coating or paint used in interior applications.

1.04 REFERENCE STANDARDS AND REGULATORY REQUIREMENTS

- A. General: Rules and regulations of other jurisdictions are cited as the reference standard for certain types of pollutants. These reference standards are fully applicable to the Work even though the project is not located in those jurisdictions.
- B. Rule 1168 – “Adhesive and Sealant Applications”, effective date of July 1, 2005, and Rule Amendment date of January 7, 2005: South Coast Air Quality Management District (SCAQMD), State of California, www.aqmd.gov.
- C. Green Seal Standard for Commercial Adhesives GS-36, requirements in effect October 19, 2000.
- D. “Green Seal Standard for Architectural Coating” (GS-11), plus “Green Seal Standard for Anti-Corrosive Paints” (GC-03).
- E. Rule 1113 -: Architectural Coatings”, amended 7/9/04: South Coast Air Quality Management District (SCAQMD), State of California, www.aqmd.gov.

1.05 GREEN BUILDING GENERAL REQUIREMENTS

- A. The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental goals. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below and in related sections of the contract documents, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated GREEN BUILDING Performance Criteria.

1.06 VOC REQUIREMENTS FOR ADHESIVES

- A. The volatile organic compound (VOC) content of adhesives, adhesive bonding primers, or adhesive primers used in this project shall not exceed the limits defined in Rule 1168 – “Adhesive and Sealant Applications” of the South Coast Air Quality Management District (SCAQMD), of the State of California.
- B. VOC content of aerosol adhesives shall not exceed the limits defined in the Green Seal Standard for Commercial Adhesives GS-36, requirements in effect October 19, 2000.
- C. The VOC limits defined by SCAQMD (based on 1/7/05 amendments) are as follows. All VOC limits are defined in grams per liter, less water and less exempt compounds.
- D. General: Unless otherwise specified below, the VOC content of all adhesives, adhesive bonding primers, or adhesive primers shall not be in excess of 250 grams per liter.
- E. For specified applications, the allowable VOC content is as follows:
 - 1. Architectural Applications;
 - a. Indoor carpet adhesive 50
 - b. Carpet pad adhesive 50
 - c. Outdoor carpet adhesive 150
 - d. Wood flooring adhesive 100
 - e. Rubber floor adhesive 60
 - f. Sub-floor adhesive 50
 - g. Ceramic tile adhesive 65

- h. LVT adhesive 50
- i. Drywall and panel adhesive 50
- j. Cove base adhesive 50
- k. Multipurpose construction adhesive 70
- l. Structural glazing adhesive 100
- m. Single ply roof membrane adhesive 250
- 2. Specialty Applications
 - a. PVC welding 150
 - b. CPVC welding 490
 - c. ABS welding 325
 - d. Plastic cement welding 250
 - e. Adhesive primer for plastic 550
 - f. Contact adhesive 80
 - g. Special purpose contact adhesive 250
 - h. Adhesive primer for traffic marking tape 150
 - i. Structural wood member adhesive 140
 - j. Sheet applied rubber lining operations 850
- 3. Substrate Specific Applications
 - a. Metal to metal 30
 - b. Plastic foams 50
 - c. Porous material (except wood) 50
 - d. Wood 30
 - e. Fiberglass 80
- F. If an adhesive is used to bond dissimilar substrates together, the adhesive with the highest VOC content shall be allowed.

- G. VOC limits for Aerosol Adhesives (defined as percentage of VOC weight in grams per liter less water)
 - 1. General purpose mist spray 65% VOCs by weight
 - 2. General purpose web spray 55% VOCs by weight
 - 3. Special purpose aerosol adhesives (all types) 70% VOCs by weight

1.07 REQUIREMENTS FOR SEALANTS

- A. The VOC content of sealants or sealant primers used in this project shall not exceed the limits defined in Rule 1168 – “Adhesives and Sealant Applications” of the South Coast Air Quality Management District (SCAQMD).
- B. The VOC limits defined by SCAQMD Rule 1168. All VOC limits are defined in grams per liter, less exempt compounds.
 - 1. Sealants:
 - a. Architectural 250
 - b. Marine deck 760
 - c. Roadways 250
 - d. Single-ply roof material installation/repair 450
 - e. Non-membrane roof installation/repair 300
 - f. Other 420
 - 2. Sealant Primer:
 - a. Architectural – nonporous 250
 - b. Architectural – porous 775
 - c. Other 750

1.08 VOC LIMIT REQUIREMENTS FOR PAINTS

- A. Paints and Primers (Non-specialized applications): Paints and primers used in nonspecialized interior and exterior applications shall meet the VOC and chemical component limitations of the Green Seal Paint Standard GS-11, and anti-corrosive paints (those used in preventing the corrosion of ferrous metal substrates) shall meet the VOC and chemical component limitations of Green Seal Standard GC-03 of Green Seal, Inc., Washington, DC. Product-specific environmental requirements are as follows:

1. VOC concentrations (in grams per liter) of the product shall not exceed those listed below as determined by U. S. Environmental Protection Agency (EPA) Reference Test Method 24.
2. Interior Coatings:
 - a. Non-flat 150
 - b. Flat 50
3. Interior Anti-Corrosive Paints:
 - a. Gloss 250
 - b. Semi-gloss 250
 - c. Flat 250
4. Exterior Coatings:
 - a. Non-flat 200
 - b. Flat 100
5. The calculation of VOC shall exclude water and tinting color added at the point of sale.
6. Chemical Component Limitations -Aromatic Compounds: the product must contain no more than 1.0% by weight of the sum total of aromatic compounds. Testing for the concentration of these compounds will be performed if they are determined to be present in the product during a materials audit.
7. Chemical Component Limitations -Other Chemicals: the manufacturer shall demonstrate that the following chemical compounds are not used as ingredients in the manufacture of the product.
 - a. Halomethanes: methylene chloride
 - b. Chlorinated ethanes: 1,1,1-trichloroethane
 - c. Aromatic solvents: benzene, toluene (methylbenzene), ethylbenzene
 - d. Chlorinated ethylenes: vinyl chloride
 - e. Polynuclear aromatics: naphthalene
 - f. Chlorobenzenes: 1,2-dichlorobenzene

- g. Phthalate esters: di (2-ethylhexyl) phthalate, butyl benzyl phthalate, di-n-butyl phthalate, di-n-octyl phthalate, diethyl phthalate, dimethyl phthalate
 - h. Miscellaneous semi-volatile organics: isophorone
 - i. Metals and their compounds: antimony, cadmium, hexavalent chromium, lead, mercury
 - j. Preservatives (antifouling agents): formaldehyde
 - k. Ketones: methyl ethyl ketone, methyl isobutyl ketone
 - l. Miscellaneous volatile organics: acrolein, acrylonitrile
- B. Paints and other Architectural Coatings (Specialized applications): Paints and other architectural coatings used in specialized interior and exterior applications (as defined below) shall meet the VOC limitations defined in Rule 1113, “Architectural Coatings” of SCAQMD, of the State of California. The VOC limits defined by SCAQMD, based on 7/9/04 amendments, are as follows. VOC limits are defined in grams per liter, less water and less exempt compounds.
 - 1. Bond Breakers: 350
 - 2. Clear Wood Finishes
 - a. Varnish 275
 - b. Sanding Sealers: 275
 - c. Lacquer: 275
 - 3. Clear Brushing Lacquer: 275
 - 4. Concrete-Curing Compounds: 350
 - 5. Dry-Fog Coatings: 400
 - 6. Fire-Proofing Exterior Coatings: 350
 - 7. Fire-Retardant Coatings
 - a. Clear: 650
 - b. Pigmented: 350
 - 8. Floor Coatings: 50
 - 9. Graphic Arts (Sign) Coatings: 500

10. Industrial Maintenance (IM) Coatings: 100
 - a. High Temperature IM Coatings: 420
 - b. Zinc-Rich IM Primers: 100
11. Japans/Faux Finishing Coatings: 350
12. Low-solids Coatings: 120
13. Magnesite Cement Coatings: 450
14. Mastic Coatings: 300
15. Metallic Pigmented Coatings: 500
16. Multi-Color Coatings: 250
17. Pigmented Lacquer: 275
18. Pre-Treatment Wash Primers: 420
19. Primers, Sealers, and Undercoaters: 100
20. Quick-Dry Enamels: 250 (50 after 7/1/06)
21. Quick-Dry Primers, Sealers, and Undercoaters: 100
22. Recycled Coatings: 250
23. Roof Coatings: 50
24. Roof Coatings, Aluminum: 100
25. Roof Primers, Bituminous: 350
26. Exterior Rust Preventative Coatings: 100
27. Shellac
 - a. Clear: 730
 - b. Pigmented: 550
28. Specialty Primers: 100
29. Stains: 100

- 30. Stains, Interior: 250
- 31. Swimming Pool Coatings
 - a. Repair: 340
 - b. Other: 340
- 32. Traffic Coatings: 150
- 33. Waterproofing Sealers: 100
- 34. Waterproofing Concrete/Masonry Sealers: 100
- 35. Wood Preservatives
 - a. Below-Ground: 350
 - b. Other: 350
- 36. Other Coating Types (not included in above): 250

PART 2 -PRODUCTS (NOT USED)

PART 3 -EXECUTION (NOT USED)

END OF SECTION 01 81 15

GENERAL COMMISSIONING REQUIREMENTS

SECTION 019113

PART 1 GENERAL

1.01 RELATED DOCUMENTS AND REFERENCED STANDARDS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Owner's Project Requirements and Basis of Design.
- C. Commissioning Plan.
- D. ASHRAE Guideline 0-2005-The Commissioning Process.
- E. ASHRAE Guideline 1.1-2007-HVAC&R Technical Requirements for The Commissioning Process

1.02 SUMMARY

- A. Commissioning is intended to achieve the following specific objectives; this section specifies the Contractor's responsibilities for commissioning.
 - 1. Verify that the work is installed in accordance with the Contract Documents and the manufacturer's recommendations and instructions, and that it receives adequate operational checkout prior to startup: Startup reports and Pre-Functional Commissioning Checklists executed by Contractor are utilized to achieve this.
 - 2. Verify and document that functional performance is in accordance with the Contract Documents: Functional Commissioning Checklists executed by Contractor and witnessed by the Commissioning Authority are utilized to achieve this.
- B. Commissioning, including Functional Commissioning Checklists, Tests, O&M documentation review, and training, is to occur after startup and initial checkout and be completed before Substantial Completion.
- C. The Commissioning Authority is employed by Owner.

1.03 DEFINITIONS

- A. BOD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative

descriptions and lists of individual items that support the design process.

- B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- C. CxA: Commissioning Authority.
- D. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
- E. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.04 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including Project superintendent and Subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- B. Members Appointed by Owner:
 - 1. CxA: The designated person, company, or entity that coordinates the commissioning team to implement the commissioning process.
 - 2. Representatives of the facility user and operation and maintenance personnel.
 - 3. Architect and engineering design professionals.

1.05 OWNER'S RESPONSIBILITIES

- A. Develop the OPR documentation to the CxA and each Contractor for information and use.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
- C. Provide the BOD documentation, prepared by Architect and approved by Owner, to the CxA and each Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.06 EACH CONTRACTOR'S RESPONSIBILITIES

- A. Each Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
 3. Attend commissioning team meetings held on a weekly basis or as determined by CxA.
 4. Integrate and coordinate commissioning process activities with construction schedule.
 5. Review and accept construction checklists, Pre-functional and Functional Commissioning Checklist provided by the CxA. Provide equipment manufacturers information as requested by CxA.
 6. Complete paper construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.
 7. Review and accept commissioning process test procedures provided by the Commissioning Authority.
 8. Complete commissioning process test procedures.
 9. Perform commissioning tests at the direction of the CxA.
 10. Attend construction phase controls coordination meeting.
 11. Attend testing, adjusting, and balancing review and coordination meeting.
 12. Participate in systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
 13. Provide information requested by the CxA for final commissioning documentation.
 14. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

15. Provide commissioning services as outlined in commissioning plan and the LEED New Construction guidelines.

1.07 PRE-FUNCTIONAL AND FUNCTIONAL COMMISSIONING CHECKLISTS

- A. Pre-Functional Inspections are a systematic set of procedures intended to identify whether individual components of the systems to be commissioned have been installed properly. Pre-Functional Checklists shall be developed to insure consistency in the inspections and to document the process. The Contractors shall perform, document and complete all work indicated on the Pre-Functional and Functional Commissioning Checklists. The Contractor that installs the equipment shall also provide the Commissioning. Pre-Functional inspections can discover various installation issues and provide the opportunity to correct uncovered issues prior to Functional Testing. Functional testing occurs once all system components are installed, energized, programmed, balanced and otherwise ready for operation under part and full load conditions. Testing should include each sequence in the sequence of operations under central and packaged equipment control; including startup, shutdown, capacity modulation, emergency and failure modes, alarms and interlocks to other equipment. Systems performance testing may use a wide variety of means and methods to simulate and evaluate that the system being tested performs as expected (per the OPR/ BOD - Commissioning Plan, and Contract Documents) in all modes of operation. Systems performance testing shall be performed by the installing Contractor. Systems performance testing may yield minor or significant issues with the performance of the commissioned systems and may require significant follow-up and coordination between members of the Project team to address and resolve these issues. Evaluation of Results Compared to OPR/BOD, at each point in the process of Installation Inspections and Systems Performance Testing the CxA and the commissioning team should evaluate whether the installed systems meet the criteria for the Project as set forth by the Owner in the OPR and the designers in the BOD. Any discrepancies or deficiencies should be reported to the Owner and the team should work collaboratively to find an appropriate resolution. The intent of functionally testing the system/building as a whole is to evaluate the ability of the components in a system to work together to achieve the Owner's Project Requirements. For functional testing to provide valid results, the individual components and systems have to be verified to be operating properly (Functional Checklists). This includes testing each sequence in the sequence of operations, startup, shutdown, interlocks, capacity modulation, safety items and capacities (testing, adjusting, and balancing). Checklists will be printed on standard letter paper size and all checklists share the following common attributes.
 1. Each checklist is assigned to a specific component (i.e. tag number or area) for checklists.
 2. Each checklist contains an equipment tag and number. This equipment tag and number is utilized to track the checklist completion and "No" responses.

3. All checklists contain a region for recording “No” responses. The intent of this section is to provide Contractors with a means to track instances where the Owner’s requirements are not met for future resolution.

1.08 DEVELOP AND USE PRE-FUNCTIONAL AND FUNCTIONAL CHECKLISTS

- A. The Commissioning checklists are developed by the Commissioning Authority and issued to Owner’s Representative, General Contractor, Design Team, HVAC Contractor, Plumbing Contractor and Electrical Contractor. The intent of commissioning checklists is to convey pertinent information to the installers regarding the Owner’s Project Requirements. The checklists are structured to be short and simple by focusing on key elements. The checklists include testing, adjusting, and balancing (TAB) and control system tuning. The development of the Functional Checklists takes close coordination between the Commissioning Authority and Contractors to maximize the benefits of the checklists and to tailor the checklists to the Project. The key steps in the development of the checklists are:
 1. CxA identifies components and systems for which checklists are required.
 2. CxA reviews Owner’s requirements for key success criteria.
 3. CxA reviews specifications and drawings information for key requirements.
 4. CxA sets up spreadsheet identifying all equipment to be commissioned.
 5. CxA develops sample checklists.
 6. CxA provides sample checklists to Owner’s Representative for review and to forward to General Contractor, HVAC Contractor, Plumbing Contractor and Electrical Contractor for their review and comment.
 7. CxA finalizes commissioning checklists based upon Owner and Contractor feedback.
 8. CxA prints commissioning checklists.
 9. CxA sends commissioning checklists and spreadsheets to Owner’s Representative for distribution.
 10. The key steps for the contractors who will be using the checklists are:
 - a. At the start of each workday, Contractors remove the checklists that will be needed for that day from a designated file cabinet.
 - b. As work is completed, the individual workers fill out the appropriate checklist and describe any “No” responses at the side and bottom of each checklist.

11. At the end of the day:
 - a. Give the completed checklists to the responsible party designated by the General Contractor to scan the checklists.
 - b. Return any checklists that were not completed to the file cabinet.
12. The responsible party designated by the General Contractor should scan the completed checklists and email the completed checklists to the CxA on a weekly basis.
13. Once the checklists have been developed and provided to the General Contractor, the Commissioning Authority will review the completion of the checklists periodically during their site visits. The results of the review will be included in the site visit report and provided to the Contractors and Owner.
14. Two (2) types of commissioning checklists will be developed for this project: Pre-Functional and Functional.

1.09 DEVELOP AND IMPLEMENT A MASTER DEFICIENCY LOG

- A. The CxA shall develop a Master Deficiency log to provide a clear way of managing the deficiencies as a single document.
- B. The Master Deficiency Log will be updated by the CxA. The Contractors shall assist with documenting the deficiencies by notifying the CxA of the issues within 72 hours of discovery.

1.10 CxA'S RESPONSIBILITIES

- A. Provide Project-specific pre-functional and functional commissioning checklists based on Contractor input for actual systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Develop commissioning plan.
- C. Develop pre-functional and functional commissioning checklists.
- D. Review Contractors completed pre-functional and functional commissioning checklists.
- E. Complete a summary commissioning report.

1.11 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning

plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing pre-functional and functional commissioning checklists and manufacturer's prestart and startup checklists for systems, assemblies, equipment, and components to be verified, tested (commissioned).
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

1.12 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.
- C. Manufacturers' Instructions: Submit copies of all manufacturer-provided instructions that are shipped with the equipment as soon as the equipment is delivered.
- D. Product Data: If submittals to Architect do not include the following, submit copies as soon as possible:
 1. Manufacturer's product data, cut sheets, and shop drawings.
 2. Manufacturer's installation instructions.
 3. Startup, operating, and troubleshooting procedures.
 4. Fan and pump curves.
 5. Factory test reports.

6. Warranty information, including details of Owner's responsibilities in regard to keeping warranties in force.
- E. Startup Plans and Reports.
- F. Completed Pre-Functional and Functional Commissioning Checklists.
- G. Make commissioning submittals on time schedule specified by Commissioning Authority.
- H. Submittals indicated as "Draft" are intended for the use of the Commissioning Authority in preparation of Pre-Functional Commissioning Checklists or Functional Commissioning Checklists; submit in editable electronic format, Microsoft Word (latest edition) preferred.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A. Provide all standard testing equipment required to perform startup and initial checkout and required Functional Testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
- B. Calibration Tolerances: Provide testing equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply
 1. Temperature Sensors and Digital Thermometers: Certified calibration within past year to accuracy of 0.5-degree F and resolution of plus/minus 0.1-degree F.
 2. Pressure Sensors: Accuracy of plus/minus 2.0 percent of the value range being measured (not full range of meter), calibrated within the last year.
 3. Calibration: According to the manufacture's recommended intervals and when dropped or damaged; affix calibration tags or keep certificates readily available for inspection.
- C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.
- D. Dataloggers: Independent equipment and software for monitoring flows, currents, status, pressures, etc. of equipment.

PART 3 EXECUTION

3.01 COMMISSIONING PLAN

- A. Commissioning Authority has prepared the Commissioning Plan.
 - 1. Attend meetings called by the Commissioning Authority for purposes of completing the commissioning plan.
 - 2. Require attendance and participation of relevant subcontractors, installers, suppliers, and manufacturer representatives.
- B. Contractor is responsible for compliance with the Commissioning Plan.
- C. Commissioning Plan: The commissioning schedule, procedures, and coordination requirements for all parties in the commissioning process.
- D. Commissioning Schedule:
 - 1. Submit anticipated dates of startup of each item of equipment and system to Commissioning Authority within 60 days after award of Contract.
 - 2. Re-submit anticipated startup dates monthly, but not less than 4 weeks prior to startup.
 - 3. Pre-functional Commissioning Checklists and Functional Commissioning Checklists are to be performed in sequence from components, to subsystems, to systems.
 - 4. Provide sufficient notice to Commissioning Authority for delivery of relevant Checklists and Functional Test procedures, to avoid delay.

3.02 STARTUP PLANS AND REPORTS

- A. Startup Plans: For each item of equipment and system for which the manufacturer provides a startup plan, submit the plan not less than 8 weeks prior to startup.
- B. Startup Reports: For each item of equipment and system for which the manufacturer provides a startup checklist (or startup plan or field checkout sheet), document compliance by submitting the completed startup checklist prior to startup, signed and dated by responsible entity.
- C. Submit directly to the Commissioning Authority.

3.03 PREFUNCTIONAL CHECKLISTS

- A. Pre-functional Checklist is required to be filled out for each item of equipment or other assembly specified to be commissioned.
 - 1. No sampling of identical or near-identical items is allowed.
 - 2. These checklists do not replace manufacturers' recommended startup checklists, regardless of apparent redundancy.
 - 3. Pre-functional Checklist forms will not be complete until after award of the contract; the following types of information will be gathered via the completed Checklist forms:
 - a. Certification by installing contractor that the unit is properly installed, started up, and operating and ready for Functional Testing.
 - b. Confirmation of receipt of each shop drawing and commissioning submittal specified, itemized by unit.
 - c. Manufacturer, model number, and relevant capacity information; list information "as specified," "as submitted," and "as installed."
 - d. Serial number of installed unit.
 - e. List of inspections to be conducted to document proper installation prior to startup and Functional Testing; these will be primarily static inspections and procedures; for equipment and systems may include normal manufacturer's start-up checklist items and minor testing.
 - f. Sensor and actuator calibration information.
- B. Contractor is responsible for filling out Pre-Functional Checklists, after completion of installation and before startup; witnessing by the Commissioning Authority is not required unless otherwise specified.
 - 1. Each line item without deficiency is to be witnessed, initialed, and dated by the actual witness; checklists are not complete until all line items are initialed and dated complete without deficiencies.
 - 2. Checklists with incomplete items may be submitted for approval provided the Contractor attests that incomplete items do not preclude the performance of safe and reliable Functional Testing; re-submission of the Checklist is required upon completion of remaining items.
 - 3. Individual Checklists may contain line items that are the responsibility of more than one installer; Contractor shall assign responsibility to appropriate installers or subcontractors, with identification recorded on the form.
 - 4. If any Checklist line item is not relevant, record reasons on the form.

5. Contractor may independently perform startup inspections and/or tests, at his option.
 6. Regardless of these reporting requirements, Contractor is responsible for correct startup and operation.
 7. Submit completed Checklists to Commissioning Authority within two days of completion.
- C. Commissioning Authority is responsible for furnishing the Pre-functional Checklists to Contractor
1. Initial Drafts: Contractor is responsible for initial draft of Pre-functional Checklist where so indicated in the Contract Documents.
 2. Provide all additional information requested by Commissioning Authority to aid in preparation of checklists, such as shop drawing submittals, manufacturers' startup checklists, and O&M data.
 3. Commissioning Authority may add any relevant items deemed necessary regardless of whether they are explicitly mentioned in the Contract Documents or not.
 4. When asked to review the proposed Checklists, do so in a timely manner.
- D. Commissioning Authority Witnessing: Required for:
1. Each piece of primary equipment, unless sampling of multiple similar units is allowed by the commissioning plan.
 2. A sampling of non-primary equipment, as allowed by the commissioning plan.
- E. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.
1. If difficulty in correction would delay progress, report deficiency to the Commissioning Authority immediately.

3.04 FUNCTIONAL TESTS

- A. A Functional Test is required for each item of equipment, system, or other assembly specified to be commissioned, unless sampling of multiple identical or near-identical units is allowed by the final test procedures.
- B. Contractor is responsible for execution of required Functional Tests, after completion of Pre-Functional Checklist and before closeout.
- C. Commissioning Authority is responsible for witnessing Functional Tests.

- D. Contractor is responsible for correction of deficiencies and re-testing at no extra cost to Owner; if a deficiency is not corrected and re-tested immediately, the Commissioning Authority will document the deficiency and the Contractor's stated intentions regarding correction.
1. Deficiencies are any condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents or does not perform properly.
 2. When the deficiency has been corrected, the Contractor completes the form certifying that the item is ready to be re-tested and returns the form to the Commissioning Authority; the Commissioning Authority will reschedule the test and the Contractor shall re-test.
 3. Identical or Near-Identical Items: If 10 percent, or three, whichever is greater, of identical or near-identical items fail to perform due to material or manufacturing defect, all items will be considered defective; provide a proposal for correction within 2 weeks after notification of defect, including provision for testing sample installations prior to replacement of all items.
 4. Contractor shall bear the cost of Owner and Commissioning Authority personnel time witnessing re-testing.
 5. Contractor shall bear the cost of Owner and Commissioning Authority personnel time witnessing re-testing if the test failed due to failure to execute the relevant Pre-Functional Checklist correctly; if the test failed for reasons that would not have been identified in the Pre-Functional Checklist process, Contractor shall bear the cost of the second and subsequent re-tests.
- E. Functional Commissioning Checklist Procedures:
1. Some test procedures are included in the Contract Documents; where Functional Test procedures are not included in the Contract Documents, test procedures will be determined by the Commissioning Authority with input by and coordination with Contractor.
 2. Examples of Functional Testing:
 - a. Test the dynamic function and operation of equipment and systems (rather than just components) using manual (direct observation) or monitoring methods under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint).
 - b. 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.

- c. Systems are run through all the HVAC control system's sequences of operation and components are verified to be responding as the sequence's state.
 - d. Traditional air or water test and balancing (TAB) is not Functional Testing; spot checking of TAB by demonstration to the Commissioning Authority is Functional Testing.
- F. Deferred Functional Tests: Some tests may need to be performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions; performance of these tests remains the Contractor's responsibility regardless of timing.

3.05 SENSOR AND ACTUATOR CALIBRATION

- A. Calibrate all field-installed temperature, relative humidity, carbon monoxide, carbon dioxide, and pressure sensors and gages, and all actuators (dampers and valves) on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.
- B. Calibrate using the methods described below; alternate methods may be used, if approved by Owner beforehand. See PART 2 for test instrument requirements. Record methods used on the relevant Pre-Functional Checklist or other suitable forms, documenting initial, intermediate and final results.
- C. All Sensors:
 - 1. Verify that sensor location is appropriate and away from potential causes of erratic operation.
 - 2. Verify that sensors with shielded cable are grounded only at one end.
 - 3. For sensor pairs that are used to determine a temperature or pressure difference, for temperature make sure they are reading within 0.2 degree F of each other, and for pressure, within tolerance equal to 2 percent of the reading, of each other.
 - 4. Tolerances for critical applications may be tighter.
- D. Sensors Without Transmitters – Standard Application
 - 1. Make a reading with a calibrated test instrument within 6 inches of the site sensor.
 - 2. Verify that the sensor reading, via the permanent thermostat, gage or building automation system, is within the tolerances in the table below of the instrument-measured value.

3. If not, install offset, calibrate or replace sensor.
- E. Sensors With Transmitters – Standard Application:
1. Disconnect sensor.
 2. Connect a signal generator in place of sensor.
 3. Connect ammeter in series between transmitter and building automation system control panel.
 4. Using manufacturer's resistance-temperature data, simulate minimum desired temperature.
 5. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter.
 6. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the building automation system.
 7. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship and P/I reaction.
 8. Reconnect sensor.
 9. Make a reading with a calibrated test instrument within 6 inches of the site sensor.
 10. Verify that the sensor reading, via the permanent thermostat, gage or building automation system, is within the tolerances in the table below of the instrument-measured value.
 11. If not, replace sensor and repeat.
 12. For pressure sensors, perform a similar process with a suitable signal generator.
- F. Sensor Tolerances for Standard Applications: Plus/minus the following maximums:
1. Watthour, Voltage, Amperage: 1 percent of design.
 2. Pressure, Air, Water, Gas: 3 percent of design.
 3. Air Temperatures (Outside Air, Space Air, Duct Air): 0.4 degrees F.
 4. Relative Humidity: 4 percent of design.
 5. Barometric Pressure: 0.1 inch of Hg(.

6. Flow Rate, Air: 10 percent of design.
 7. Flow Rate, Water: 4 percent of design.
 8. AHU Wet Bulb and Dew Point: 2.0 degrees F.
- G. Critical Applications: For some applications, more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.
- H. Valve/Damper Stroke Setup and Check:
1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
 2. Set pump/fan to normal operating mode.
 3. Command valve/damper closed: visually verify that valve/damper is closed and adjust output zero signal as required.
 4. Command valve/damper to open; verify position is full open and adjust output signal as required.
 5. Command valve/damper to a few intermediate positions.
 6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
- I. Isolation Valve or System Valve Leak Check: For valves not associated with coils
1. With full pressure in the system, command valve closed.
 2. Use an ultra-sonic flow meter to detect flow or leakage.

3.06 TEST PROCEDURES – GENERAL

- A. Provide skilled technicians to execute starting of equipment and to execute the Functional 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.
- B. Provide all necessary materials and system modifications required to produce the flows, pressures, temperatures, and conditions necessary to execute the test according to the specified conditions. At completion of the test, return all affected equipment and systems to their pre-test condition.
- C. Sampling: Where Functional Testing of fewer than the total number of multiple identical or near-identical items is explicitly permitted, perform sampling as follows:

1. Identical Units: Defined as units with same application and sequence of operation; only minor size or capacity difference.
 2. Sampling is not allowed for:
 - a. Major equipment.
 - b. Life-safety-critical equipment.
 - c. Pre-Functional Checklist execution.
 3. XX = the percent of the group of identical equipment to be included in each sample; defined for specific type of equipment.
 4. YY = the percent of the sample that if failed will require another sample to be tested; defined for specific type of equipment.
 5. Randomly test at least XX percent of each group of identical equipment, but not less than three units. This constitutes the “first sample.”
 6. If YY percent of the units in the first sample fail, test another XX percent of the remaining identical units.
 7. If YY percent of the units in the second sample fail, test all remaining identical units.
 8. If frequent failures occur, resulting in more troubleshooting than testing, the Commissioning Authority may stop the testing and require Contractor to perform and document a checkout of the remaining units prior to continuing testing.
- D. Manual Testing: Use hand-held instruments, immediate control system readouts, or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the “observation”).
- E. Simulating Conditions: Artificially create the necessary condition for the purpose of testing the response of a system; for example, apply hot air to a space sensor using a hair dryer to see the response in a VAV box.
- F. Simulating Signals: Disconnect the sensor and use a signal generator to send an amperage, resistance or pressure to the transducer and control system to simulate the sensor value
- G. Over-Writing Values: Change the sensor value known to the control system in the control system to see the response of the system; for example, change the outside air temperature value from 50 degrees F to 75 degrees F to verify economizer operation.

- H. Indirect Indicators: Remote indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100 percent closed, are considered indirect indicators.
- I. Monitoring: Record parameters (flow, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of the relevant control systems: where monitoring of specific points is called for in Functional Test Procedures:
 - 1. All points that are monitored by the relevant control system shall be trended by Contractor; at the Commissioning Authority's request, Contractor shall trend up to 20 percent more points than specified at no extra charge.
 - 2. Other points will be monitored by the Commissioning Authority using dataloggers.
 - 3. At the option of the Commissioning Authority, some control system monitoring may be replaced with datalogger monitoring.
 - 4. Provide hard copies of monitored data in columnar format with time down left column and at least 5 columns of point values on same page.
 - 5. Graphical output is desirable and is required for all output if the system can produce it.
 - 6. Monitoring may be used to augment manual testing.

3.07 TESTING PREPARATION

- A. Certify that systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.

- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to
- H. Record test data as directed by the CxA.

3.08 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.09 GENERAL TESTING AND COMMISSIONING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of testing and commissioning shall include all systems and subsystems in accordance with the LEED New Construction Guidelines. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

- D. The CxA along with the Contractors, testing and balancing Subcontractor, and Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical
- I. If tests cannot be completed because of a deficiency outside the scope of the system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.10 ADDITIONAL TESTING AND COMMISSIONING PROCEDURES FOR HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT

- A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.
- B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors

shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

2. Description of equipment for flushing operations.
 3. Minimum flushing water velocity.
 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of oil, gas, hot-water and solar systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

3.11 SYSTEMS, SUBSYSTEMS AND EQUIPMENT TO BE COMMISSIONED AT A MINIMUM

- A. Systems, subsystems and equipment to be commissioned at a minimum includes the following:
1. Heating, ventilating, air conditioning, and refrigeration (HVAC&R) systems (mechanical and passive) and associated controls.
 2. Lighting and day lighting controls.
 3. Domestic hot water systems.
 4. Renewable energy systems (wind, solar, etc.)
- B. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

END OF SECTION 01 19 13

SECTION 028200

ASBESTOS ABATEMENT

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Description

The "Scope of Work" covered by these specifications involves the removal and disposal of asbestos containing, and/or asbestos contaminated materials, as follows:

- A.1 Remove and dispose of the following asbestos containing, and/or asbestos contaminated materials, in the following areas located at the Tackapausha Museum 2225 Washington Avenue, Seaford, New York 11783. The removal of the following listed ACM materials must be removed only by a New York State Department of Labor (NYS DOL) licensed asbestos abatement contractor using only licensed asbestos abatement handlers:

Asbestos Containing Materials			
Tackapausha Museum			
2225 Washington Avenue, Seaford, NY 11783			
Note	Location	ACM	Notes
1	Boiler Room	Sprayed-On Fireproofing on Boiler Room Ceiling	Abatement Contractor (AC) to remove and dispose of all asbestos containing sprayed-on ceiling fireproofing in its entirety. All sprayed-on fireproofing is to be removed in its entirety down to the existing substrate. All waste generated shall be disposed of as asbestos containing waste. Abatement contractor to field verify quantities.
2	Boiler Room	Boiler Demolition	Abatement contractor (AC) to demolish existing HB Smith Boiler in its entirety down to existing concrete pad. AC to remove and dispose of all asbestos containing boiler jacket insulation, boiler breeching insulation, all interior boiler components including but not limited to boiler sand, ash, roping/gasket and fire brick. All waste generated shall be disposed of as asbestos containing waste. Abatement contractor to field verify quantities.

Asbestos Containing Materials			
Tackapausha Museum			
2225 Washington Avenue, Seaford, NY 11783			
Note	Location	ACM	Notes
3	Boiler Room	Pipe and Pipe Fitting Insulation (Including Fiberglass Pipe Insulation)	Abatement Contractor (AC) to remove and dispose of all asbestos containing asbestos contaminated pipe and pipe fitting insulation (including fiberglass pipe insulation) in its entirety down to the existing substrate. All waste generated shall be disposed of as asbestos containing waste. Abatement contractor to field verify quantities.
4	Attic Fan Room	Pipe Fitting Insulation (Pipe Elbows)	Abatement contractor (AC) to remove and dispose of all asbestos containing asbestos contaminated pipe fitting insulation including but not limited to fiberglass insulation that is included in the asbestos work area down to existing substrate. AC to field verify quantities.
5	Attic Fan Room	Vibration Reducer Cloth (white flex collar)	Abatement contractor (AC) to remove and dispose of all asbestos containing asbestos contaminated vibration reducer cloth down to existing substrate. AC to field verify quantities.

All asbestos containing material, and asbestos contaminated material abatement work shall be performed in accordance with the applicable provisions of NYS DOL Industrial Code Rule 56 (12 NYCRR Part 56), OSHA (29 CFR Part 1910) (EPA Title 40 CFR Part 61) and all other applicable federal, state, and local laws, rules and regulations having jurisdiction over this project, and shall include all aspects of worker safety & protection.

The asbestos Contractor is responsible for coordinating his work with the other Contractors on site so that the building will be protected against any damage (i.e. security, weather, etc.) and all work is completed in a timely fashion if applicable.

B. Special Variances

If the Contractor wishes to use any variances from NYS ICR 56 (applicable or otherwise) it must first be approved by the Owner or Owner's Agent. If the use of such variance is approved and requires additional air monitoring other than what is noted in section 17 of NYS ICR 56, then the Contractor shall be responsible for reimbursement of extra air monitoring costs to the Owner. The Contractor shall also be responsible for supplying the air monitoring firm with additional materials and equipment required to satisfy the variance requirements.

If the Contractor applies for the variance from the NYS DOL and it is not approved in a timely fashion adequate to complete the work within the designated time period, the Contractor must complete the scope of work without the variance at any additional cost to the Owner.

C. Personnel

The work specified shall include the preparation, removal and disposal of asbestos-containing materials (ACM) and shall be carried out by persons trained, qualified and certified in the techniques of abatement and subsequent cleaning, testing, transportation and disposal in compliance with all federal, state and local regulations.

D. Restoration

The Contractor is responsible for the cleaning and removal of all debris located in the work area and surrounding areas after the abatement has been completed. Any damages caused during the performance of abatement activities shall be repaired by the Contractor (ex. paint peeled off by barrier tape, nail holes, water damage, broken glass) at no additional expense to the building Owner.

The Contractor is responsible for restoring abatement surfaces to conditions acceptable to the building Owner, and Owner's representative. This shall include, but is not limited to lingering odors, or out gassing, from chemical methods of abatement, damage to substrates (ex. flooring, roof decking, etc.) caused by abatement techniques, and any other surface or subsurface damage caused by the abatement technique. The Contractor is responsible for the cleaning and removal of all debris located in the work area, and surrounding areas, after the abatement has been completed.

If any method of abatement results in any lingering odors, or other unexpected conditions the Contractor will be required to remediate such to pre-abatement conditions. The determination of the pre-abatement conditions will be made by the Owner, or Owner's Agent, unless otherwise documented by all parties prior to abatement activities being performed.

1.2 PERFORMANCE OF WORK

The Contractor is required to perform the scope of work in the following sequence and in accordance to the special requirements. Whenever there is a conflict between this schedule and requirements of any applicable regulations (ie. NYSDOL ICR 56, OSHA, etc.) the most stringent shall apply.

A. Preparation

The Owner shall be responsible to remove all moveable objects from the work area prior to the start of abatement activities.

The Contractor shall then proceed as follows:

The Contractor will inspect the work area, and all areas utilized throughout the project for any unsafe situations or dangerous conditions prior to the beginning of the project. The Contractor will then be responsible to take appropriate actions and steps to effectively provide a safe environment for his workers.

The Contractor shall then inspect the work area and all other areas that will be utilized throughout the abatement project for any property and/or objects damage that may exist prior to the beginning of the work. This information must be submitted to the Owner or Owner's Agent prior to the start of any work. The Contractor will be responsible for obtaining written confirmation of the Owner or Owner's Agent receipt of the submittal. The Contractor will be responsible for the repair and/or replacement any damaged materials and/or objects inside the work area, or in the areas utilized by the Contractor during the abatement project, that were not noted and acknowledged by the Owner or Owner's Agent.

The Contractor shall cordon off the work area, and all other areas utilized during the abatement, with caution tape and warning signs. The Contractor will be responsible to ensure that the cordoned off area is maintained, and cleaned, during the length of the abatement project.

The Contractor shall then construct decontamination units as required by these specifications and all applicable regulations. The decontamination units shall be constructed with a plywood, or equal, covering (exterior).

The Contractor shall then construct isolation barriers, seal critical barriers with 2 layers of 6 mil plastic and plasticize the area with an additional 2 layers of 6 mil plastic sheeting as required in accordance with NYS ICR 56. As required, then install negative air machines and test as described in these specifications and in Industrial Code Rule 56.

The Contractor shall then decommission all other electrical power to the work area. The source of the electricity to the work area shall be "marked and tagged" to avoid any unintentional initiation of electrical power to the work area during the abatement activities.

All areas in which no abatement is to take place will be sealed shut or otherwise isolated from the work area. All fixtures in the work area shall be either: (a) removed, decontaminated (HEPA vacuumed/wet wiped) and stored in plastic sheeting outside the work area, or: (b) left in place, decontaminated and plasticized individually.

Removal of asbestos shall not commence until the decontamination units and work areas have been inspected and approved by the Owner or Owner's Agent.

B. Abatement

Removal of asbestos and asbestos containing materials shall be performed in accordance with the applicable provisions of NYS DOL Industrial Code Rule 56 (12 NYCRR Part 56), OSHA and all other applicable federal, state and local laws, rules and regulations having jurisdiction over this project and includes all aspects of worker safety & protection. All other materials located in the abatement area that are not subject for removal shall be pre-cleaned and protected during the abatement in accordance with these specifications and NYS ICR 56.

After the work area has been rendered free of all visible residues, the Contractor shall request a visual inspection of from the Owner or Owner's Agent. It is then the Owner or Owner's Agent discretion whether the work area has been rendered free of all asbestos containing materials. The

Owner or Owner's Agent reserves the right to have bulk sampling performed in the work area to ensure that sufficient removal and cleanings have been performed.

C. Clearance

After the removal of asbestos, the clean up of the area shall be carried out as detailed in Industrial Code Rule 56. This shall include the applicable twelve-hour waiting periods, unless a variance allowing a shorter waiting time is applied for, received, and approved by the NYS DOL and Owner. Final clearance of the area shall be established by analysis of air samples. Aggressive final air sampling clearance shall be performed by Phase Contrast Microscopy (PCM) method of analysis in accordance with NYS ICR 56.

D. Special Requirements

The Contractor shall become familiar with special conditions at the site which must be considered during the asbestos abatement.

These conditions include but are not limited to:

The Contractor is responsible for performing a pre-inspection of each work area scheduled to be impacted by the proposed work to confirm the presence, and or absence of asbestos containing materials and to field verify the locations and quantities. Any suspect asbestos containing materials must be identified to the owner or owner's agents for sampling and confirmation. Subsequent to the sampling and confirmation of the asbestos containing materials the contractor will be responsible for the removal of all asbestos containing materials that are expected to be impacted by the proposed work.

For roof abatement projects, in addition to the removal of asbestos containing, and/or asbestos contaminated roofing materials, the Contractor is also responsible for the removal of any friable asbestos containing, and/or asbestos contaminated, thermal systems insulation (TSI) associated with the roof drains and any associated piping that may be impacted by the proposed work. The Contractor is responsible for performing a pre-inspection of each roof drain as well as any other asbestos TSI insulated piping in the area of the roof drains scheduled to be removed, replaced, or otherwise altered prior to that work being performed to confirm the presence, and or absence of asbestos containing materials. Any suspect, or asbestos containing materials, must be identified by the contractor to the owner or owner's agents for confirmation. Subsequent to the sampling and confirmation of the asbestos containing materials the contractor will be responsible for the removal of all asbestos containing materials that are expected to be impacted by the proposed work (that includes any asbestos TSI insulated piping in the area of the roof drains).

For minor project removal of asbestos containing, and/or asbestos contaminated TSI, in addition to glovebag techniques, the contractor must utilize tent or "mini-containment removal techniques as defined in NYS ICR 56. Due to the quantity of material removed these projects are classified as minor projects, under NYS ICR 56.

The contractor will be responsible for the cross contamination of asbestos fibers or suspect asbestos debris to non-work areas or areas utilized during the abatement project. In the event that

a non-work area is suspect of having been contaminated the contractor is responsible for the proper cleaning and clearance of these areas. It will be the owner or owner's agent's discretion that these areas have been sufficiently cleaned based upon their visual inspection and/or air clearance sampling. This includes, but is not limited to, debris falling in public areas, air plenums and other spaces such as between a roof deck and ceiling system. The contractor will be responsible for reimbursement to the owner for any additional costs incurred as a result of the cross contamination.

Contractor shall be responsible for providing emergency power and lighting to the work area in case of electrical failure, as needed; all power to work areas shall be brought in from outside the work area through a ground fault circuit interrupter at the source. The Owner reserves the right to have this electrical system approved by a state licensed electrician.

Contractor must provide a qualified worker to be stationed at the decontamination unit entrance to control entry into the work area. This worker must be present at the decontamination unit entrance at all times while the abatement is in progress.

The Contractor shall record results of smoke tests of all critical and isolation barriers, at the beginning and end of each shift. Contractor shall designate an individual just for this purpose (if applicable).

Once the abatement project has started, the Contractor will be responsible for notifying the Owner or Owner's Agent of the date and time of the next work day (schedule must satisfy requirements indicated elsewhere in these specifications or bidding documents) at a minimum 24 hours in advanced. If the Contractor does not notify the Owner of any cancellations, tardiness and/or postponements, the Contractor will be responsible for the reimbursement to the Owner of any costs incurred (ex. third party monitor, custodial services, etc...).

The means and methods of the asbestos removal shall be determined by the Contractor, however must be submitted in writing and approved by the Owner or Owner's Agent.

There must be a daily pre-construction meeting between the Contractor and the Owner or Owner's Agent to schedule the detail of work and work areas for each shift in advance.

A first aid kit must be provided by the Contractor on the premises, sized to correspond to the number of workers present.

GPAC licensing shall be obtained (if required).

The Contractor is responsible for enforcing personal air monitoring of the abatement workers as required. The Contractor is also responsible for ensuring that only certified workers are located within the work area and that they are wearing required respiratory and protective clothing and gear.

The Contractor must supply the Owners Agent with a waste manifest for all asbestos or asbestos contaminated waste removed from the site. All asbestos and/or asbestos contaminated materials (both friable and non-friable) must be disposed of as asbestos waste. All waste transfer shall be

performed in accordance with all federal, state, and local regulations including but not limited to NYSDEC Title 6 Part 364.

It shall be the Contractor's sole responsibility to implement and enforce all relevant OSHA regulations having jurisdiction of the abatement work, and restoration activities.

The Contractor may not store any asbestos related waste materials, whether asbestos waste or construction waste, or construction tools or materials in the work area. The work area must be cleaned and cleared at the end of each shift.

The Contractor is required to supply the Owner and Owner's Agents with required respiratory and protective clothing whenever the Owner and/or Owner's Agent desires to enter the work area.

All disposals of waste materials will be performed in accordance with all applicable federal, state and local laws, rules and regulations including but not limited to NYSDEC Title 6 Part 364. This includes the proper removal and disposal of all hazardous and regulated waste generated in conjunction with the abatement and any demolition activities. This includes but is not limited to hazardous waste generated from mastic removal; PCB light ballasts removals, etc...

It should be expected that the fire and security alarm systems, in the work area, and surrounding areas, will be decommissioned during the abatement activities. The Contractor will be responsible for the security and fire watch of the work area and the storage of asbestos contaminated waste materials on site until its removal. This includes access into the building through NFU exhausts, exterior decontamination units and containerized asbestos waste. The Contractor shall be responsible for policing the entrances to the work areas during the entire abatement project.

The Contractor will be responsible for the cross contamination of asbestos fibers or suspect asbestos debris to non work areas or areas utilized during the abatement project. In the event that a non work area is suspect of having been contaminated the Contractor is responsible for the proper cleaning and clearance of these areas. It will be the Owner or Owner's Agent's discretion that these areas have been sufficiently cleaned based upon their visual inspection and/or air clearance sampling. This includes, but is not limited to, debris falling in public areas, air plenums and other spaces such as between a roof deck and ceiling system. The Contractor will be responsible for reimbursement to the Owner for any additional costs incurred as a result of the cross contamination.

1.3 APPLICABLE STANDARDS AND GUIDELINES

A. General requirements

All work under this contract shall be done in strict accordance with all applicable federal, state and local regulations, standards and codes governing asbestos abatement and any other trade work done in conjunction with the abatement.

The most recent edition of any relevant regulation, standard, document or codes shall be in effect. Where conflict among the requirements or with these specifications exists the most stringent requirements shall be utilized.

Copies of all standards, regulations, codes and other applicable documents, including this specification shall be available at the worksite in the clean change area of the worker decontamination system. These documents will be supplied by the Contractor.

1.4 SUBMITTAL AND NOTICES

A Contractor shall prior to Commencement of Work:

The Contractor will notify in writing at least ten (10) days prior to the commencement of any on site project activity and in accordance with 40 CFR to the following agencies:

U.S Environmental Protection Agency

State of New York Dept. of Labor

In addition, all other notifications required by federal, state or local laws and regulations, will be made by the Contractor within the required time period. The Contractor shall submit proof that all required permits and notifications have been submitted and received.

B. At the Owner or Owner's Agent's request the Contractor shall provide the following:

Submit all documentation satisfactory to the Owner or Owner's Agent that the Contractor's employees, including foremen, supervisors and any other company personnel or Agents who may be exposed to airborne asbestos fibers or who may be responsible for any aspects of abatement activities, have received adequate. This will include a copy of their New York State Labor Department Asbestos Certificate for each worker who is expected to be performing on the project including the Contractor's company certificate. If a new worker is added to the project after the start of the abatement a copy of this worker's certificate must be made available prior to the worker entering the work area.

Submit documentation from a physician that all employees or Agents who may be exposed to airborne asbestos in excess of background level have been provided with an opportunity to be medically monitored to determine whether they are physically capable of working while wearing the respirator required without suffering adverse health effects. In addition, document that personnel have received medical monitoring as required in OSHA 29 CFR Part 1910. The Contractor must be aware of and provide information to the examining physician about unusual conditions in the workplace environment (e.g., high temperature, humidity, chemical contaminants) that may impact on the employees' ability to perform work activities.

Submit documentation of respirator fit testing for all Contractor employees and Agents who must enter the work area. This fit testing shall be in accordance with qualitative procedures as detailed in the OSHA Safety & Health Standards 29 CFR.

Name and address of the proposed monitoring testing laboratory and a written description of the proposed method of measuring air samples.

C. During Abatement Activities:

Prepare daily job progress reports detailing abatement activities. Include review of progress major problems and actions taken, injury reports, equipment breakdown, etc.

Prepare copies of all transport manifests, trip tickets and disposal receipts for all asbestos waste materials removed from the work area during the abatement process.

Prepare daily copies of worksite entry logbooks with information on worker and visitor access.

Prepare daily logs documenting filter changes on respirators, HEPA vacuums, negative pressure ventilation units, and other engineering controls.

Prepare results of air sampling data collected during the course of the abatement for OSHA compliance air monitoring.

Post in the clean room area of the worker decontamination enclosure a list containing the names, addresses, and telephone numbers of the Contractor, the Owner or Owner's Agent, the General Superintendent, the Air Sampling Professionals, the testing laboratory, emergency responders and any other personnel who may be required to assist during abatement activities.

Prepare and have available upon request, results of any asbestos sampling & analysis data that is collected during the course of the abatement.

1.5 SITE SECURITY

The work area is to be restricted only to authorized, trained, and protected personnel. These may include the Contractor's employees, Owner or Owner's Agent employees and representatives, state and local inspectors and any other designated individuals. A list of authorized personnel shall be established prior to job start and be posted in the clean room area.

Entry into the work area by unauthorized individuals shall be reported immediately to the Building Owner or Owner's Agent by the Contractor.

A log book shall be maintained in the clean-room area of the decontamination facility. Anyone who enters the work area must record name, affiliation, time in, and time out for each entry.

Contractor shall have control of site security during abatement operations whenever possible, in order to protect work efforts and equipment.

1.6 EMERGENCY PLANNING

Emergency planning shall be developed prior to abatement initiation by the Contractor.

Emergency procedures shall be in written form and prominently posted in the clean room area and equipment room of the worker decontamination area. Prior to entering the work area, everyone must read and sign these procedures to acknowledge receipt and understanding of work site layout, the location of emergency exits and emergency procedures. Emergency planning shall include considerations of fire, explosion, toxic atmospheres, electrical hazards, slips, trips and falls, confined spaces and heat related injury. Written procedures shall be developed by the

Contractor and Contractor's employees shall be trained in emergency procedures. Upon completion of training, the employee will sign a document indicating full understanding of the procedures.

Employees shall be trained in evacuation procedures in the event of workplace emergencies.

For life threatening injury or illness, worker decontamination shall take least priority after measures to stabilize the injured worker, remove him/her from the workplace and secure proper medical treatment.

Telephone numbers of all emergency response personnel shall be prominently posted in the clean room area and equipment room, along with the location of the nearest telephone.

1.7 CONTRACT DOCUMENTS

All work of this section shall comply with the requirements of the Conditions of the Contract (General, Supplementary and Special), with all sections of Division 1 - General Requirements, with this Section, with the Drawings, and with other Contract Documents.

All insurance shall be obtained from companies licensed to do business in the State of New York as "admitted carriers", and must be acceptable to the Owner with a "Best" rating no lower than "A".

It is the Contractor's responsibility to submit and keep current two (2) copies of certificates of insurance with the Owner or Owner's Agent. Work may not start until all insurance certificates are on file.

No work may continue and no payments will be made after the expiration date noted on the latest insurance certificate on file with the Owner or Owner's Agent.

The Owner or Owner's Agent must be notified in writing of any changes in the insurance coverage within three (3) days of the Contractor's knowledge of such change.

All insurance policies shall provide that the insurance will not be canceled or changed without thirty (30) days written notice of such cancellation or change being mailed to and received by the Owner's Representative.

The Contractor shall assist and cooperate with the Owner's Representative and its insurance carrier(s) in connection with all claims relating to the project. The Contractor will hold harmless the Owner in any actions.

The Contractor agrees to hold the building owner and their representatives harmless from any and all fines, levies, or penalties including the cost of reasonable attorney's fees issued by any jurisdictional authorities as a result of any actions or work procedures used by the Contractor or his sub-Contractors or any persons employed directly or indirectly by the Contractor.

The Contractor shall defend, indemnify and hold harmless the building owner their officers directors, employees, Agents, servants, from and against all losses (including, but not limited to, property damage and bodily injury or death resulting there from), costs, damages, claims, expenses, including attorney's fees and expenses of litigation, judgments, liens and encumbrances, arising out of or in any way connected with the Services of the Contractor or that of any sub-Contractor and whenever made or incurred, including any and all liability imposed by law, contract, custom upon the building owner their officers, directors, employees, Agents, and servants or any or all of them, whether or not it be claimed or proven that there was negligence or breach of statutory duty or both upon the part of the building owner their officers, directors, employees, Agents, servants except where indemnity would be precluded by New York State General Obligations Law, Section 322.1, or by other applicable law. In accordance with the above, the building owner shall have the right to demand that the Contractor undertake to defend both the building owner its officers, directors, employees, Agents, servants against all lawsuits for which the Contractor has the duty to indemnify the Owner. In the event that the Contractor indemnifies the Owner for any damages, losses, costs, and expenses, which result from the negligence of a third party, the building owner will assign to the Contractor any corresponding cause of action that it may have against such third parties.

The Owner will not purchase property insurance. All insurance is to be carried by the Contractor with the building owner as additional insured.

PART 2 - MATERIALS

2.1 MATERIALS

Whenever a conflict exists between one of the following statements and that from any other applicable regulation or source the most stringent shall apply. The final interpretation must be approved by the Owner or Owner's Agent.

A. General

Deliver all materials in the original packages, containers or bundles bearing the name of the manufacturer and the brand name (where applicable).

Store all materials subject to damage off the ground, away from wet or damp surfaces and under cover sufficient enough to prevent damage or contamination. Replacement materials shall be stored outside of the work area until abatement is completed. No asbestos waste may be stored in the work area overnight. All waste must be removed at the end of each shift.

Areas utilized outside the work area used for storage must be maintained in a neat and safe manner.

Disposal bags shall be of 6 mil polyethylene, pre- printed with labels as required by EPA regulation 40 CFR or OSHA requirement 29 CFR Part 1910 and Department of Transportation regulations.

B. Removal

Surfactant (wetting Agent) shall be a 50/50 mixture of polyoxyethylene ether and polyoxyethylene ester, or equivalent, mixed in a proportion of 1 fluid ounce to 5 gallons of water or as specified by manufacturer. (An equivalent surfactant shall be understood to mean a material with a surface tension of 29 dynes/cm as tested in its properly mixed concentration, using ASTM methods. Where work area temperature may cause freezing of the amended water solution, the addition of ethylene glycol in amounts sufficient to prevent freezing is permitted.

Glove bags shall be a minimum 6 mils. thick clear poly bags with permanently attached arms with latex gloves specially designed for removing asbestos-containing material from pipes.

Encapsulating Agent is not to be applied to surfaces from which asbestos containing material has been stripped.

2.2 EQUIPMENT

A. General

A sufficient number of negative pressure ventilation units equipped with HEPA filtration and operated in accordance with ANSI 29.2-70 (local exhaust ventilation requirements) and EPA guidance document EPA 560/5-85-024 Guidance for Controlling Friable Asbestos-Containing Materials in Buildings Appendix J: Recommended specifications and operating procedures for the use of negative pressure systems for asbestos abatement shall be utilized so as to provide one workplace air change every 15 minutes.

Full body disposable protective clothing, including head, body and foot coverings consisting of material impenetrable by asbestos fibers (Tyvek R or equivalent) shall be provided to all workers and authorized visitors in sizes adequate to accommodate movement without tearing.

Additional safety equipment (e.g., hard hats meeting the requirements of ANSI Standard Z89.1-1981, eye protection meeting the requirements of ANSI Standard Z87.1-1979, safety boots meeting the requirements of ANSI Standard Z41.1-1967, disposable PVC gloves necessary, shall be provided to all workers and authorized visitors.

B. Removal

A sufficient supply of scaffolds, ladders, lifts and hand tools (e.g., scrapers, wire cutters, brushes, utility knives, wire saws, etc.) shall be provided as needed.

Sprayers with pumps capable of providing 500 pounds per square inch (psi) at the nozzle tip at a flow rate of 2 gallons per minute for spraying amended water.

Rubber dustpans and rubber squeegees shall be provided for cleanup.

Brushes utilized for removing loose asbestos containing material shall have nylon or fiber bristles, not metal.

A sufficient supply of HEPA filtered vacuum systems shall be available during cleanup.

PART 3 - METHOD

Whenever a conflict exists between one of the following statements and that from any other applicable regulation or source the most stringent shall apply. The final interpretation must be approved by the Owner or Owner's Agent.

3.1 PREPARATION

A. Work Areas

The Contractor shall post caution signs meeting the specifications of OSHA 29 CFR 1910 at any location and approaches to a location where airborne concentrations of asbestos may exceed ambient background levels. Signs shall be posted at a distance sufficiently far enough away from the work area to permit an employee to read the sign and take the necessary protective measures to avoid exposure. Additional signs may need to be posted following construction of workplace enclosure barriers.

The Contractor shall ensure that HVAC Systems are shut down and seal all intakes and exhaust vents in the work area with duct tape and 6-mil polyethylene. Also seal any seams in system components that pass through the work area. Remove all HVAC system filters and place in labeled 6-mil polyethylene bags for staging and eventual disposal as asbestos contaminated waste.

The Contractor shall pre-clean contaminated moveable objects within the work area using a HEPA filtered Vacuum and/or wet cleaning methods as appropriate. After cleaning, these objects shall be removed from the work area.

The Contractor shall pre-clean all fixed objects in the work area.

The Contractor shall pre-clean all surfaces in the work area using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Do not use any methods that would raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filters. Do not disturb asbestos containing materials during the pre-cleaning phase.

The Contractor shall seal off all windows, doorways, elevator openings, corridor entrances, drains, ducts, grills, grates, diffusers, skylights and any other openings between the work area and uncontaminated areas outside of the work area (including the outside of the building, tunnels and crawl spaces) with 6-mil polyethylene sheeting and duct tape.

Plastic shall be sized to minimize seams. If the floor area necessitates seams, those on successive layers of sheeting shall be staggered to reduce the potential for water to penetrate to the flooring material. A distance of at least 6 feet between seams is sufficient. Do not locate any seams at wall/floor joints.

Floor sheeting, if utilized shall extend at least 16 inches up the sidewalls of the work area and fasten securely to the wall.

Sheeting shall be installed in a fashion so as to prevent slippage between successive layers of material. (Vinyl sheeting may be used for improved traction on floors).

The Contractor shall cover walls in the work area with (2) layers of polyethylene sheeting.

Plastic shall be sized to minimize seams. Seams shall be staggered and separated by a distance of at least 6 feet.

Wall sheeting shall overlap floor sheeting if used by at least 12 inches beyond the wall/floor joint to provide a better seal against water damage and for negative pressure.

Wall sheeting shall be secured adequately to prevent it from falling away from the walls. This will require additional support/attachment when negative pressure systems are utilized.

B. Worker decontamination enclosure systems

Worker decontamination enclosure systems shall be provided at all locations where workers will enter or exit the work area. The worker decontamination enclosure system shall be constructed as required by New York State Industrial Code Rule. In addition, the exterior shell of the decontamination unit shall be constructed of plywood, or equal, and shall be equipped with a lockable door, with a key provided to the Owner's representative.

C. Waste Container Pass-out

Asbestos contaminated waste that has been containerized shall be transported out of the work area through the waste container pass-out airlock in accordance with ICR 56.

D. Negative Pressure Systems

Negative pressure ventilation equipment shall operate continuously, 24 hours a day, from the establishment of isolation barriers through successful clearance air monitoring. If such equipment shuts off, adjacent areas shall be monitored for asbestos fibers.

A static negative air pressure of 0.02 inches (minimum) water column shall be maintained at all times in the work place during abatement to ensure that contaminated air in the work area does not filter back to uncontaminated areas.

E. Emergency Exits

Emergency exits shall be established and clearly marked with duct tape arrows or other effective designation to permit easy location from anywhere within the work area. They shall be secured to prevent access from uncontaminated areas and still permit emergency exiting. These exits shall be properly sealed with polyethylene sheeting which can be cut to permit egress if needed.

These exits may be the worker decontamination enclosure, the waste pass-out airlock and/or other alternative exits satisfactory to fire officials.

3.2 PROCEDURES

A. Commencement of Work

Commencement of work shall not occur until:

Enclosure systems have been constructed and tested.

Negative pressure ventilation systems are functioning adequately and are tested.

All equipment for abatement, clean-up and disposal are on hand.

All worker training and certification is completed, as required.

3.3 PERSONNEL PROTECTION REQUIREMENTS

A. Training

Prior to commencement of abatement activities all personnel who will be required to enter the work area or handle containerized asbestos containing materials must have received adequate training and certification which includes but is not limited to NYSDOH Title 10 Part 73. Special on-site training on equipment and procedures unique to this job site shall be performed as required. Training in emergency response and evacuation procedures shall be provided.

B. Respiratory Protection

Respiratory protection shall be provided to workers in accordance with the submitted written respiratory protection program which shall meet the requirements of the most recent regulations.

C. Testing

Workers must perform positive and negative air pressure fit tests each time a respirator is put on, whenever the respirator design so permits. Powered air-purifying respirators shall be tested for adequate flow as specified by the manufacturer. All other testing of respiratory protection devices shall be performed in strict accordance with the most recent regulations having jurisdiction over respiratory protection.

D. Protective Clothing

Disposable clothing including head, foot and full body protection shall be provided in sufficient quantities and adequate sizes for all workers and authorized visitors.

E. Personal Monitoring

Sampling shall be conducted in accordance with CFR 1926.58 Appendix A.

3.4 REMOVAL PROCEDURES

Clean and isolate the work area.

Wet all asbestos containing material with an amended water solution using equipment capable of providing a fine spray mist, in order to reduce airborne fiber concentrations when the material is disturbed.

Saturate the material to the substrate; however, do not allow excessive water to accumulate in the work area. Keep all removed material wet enough to prevent fiber release until it can be containerized for disposal. Maintain a high humidity in the work area by misting or spraying to assist in fiber settling and reduce airborne concentrations. Wetting procedures are not equally effective on all types of asbestos containing materials but, shall none-the-less be used in all cases.

Saturated asbestos containing material shall be removed in manageable sections. Removed material should be containerized before moving to a new location for continuance of work. Surrounding areas shall be periodically sprayed and maintained in a wet condition until visible material is cleaned up.

Material removed from building structures or components shall not be dropped or thrown to the floor or ground. Material should be removed as intact sections or components whenever possible and carefully lowered to the floor. If this cannot be done for materials greater than 50 feet above the floor, a dust-tight chute shall be constructed to transport the material to containers on the floor or the material may be containerized on the floor or the material may be containerized at elevated levels (e.g. on scaffolds) and carefully lowered to the ground by mechanical means. For materials between 15 and 50 feet above the ground they may be containerized at elevated levels or dropped onto inclined chutes or scaffolding for subsequent collection and containerization.

Containers (6-mil polyethylene bags or drums) shall be sealed when full. (Wet material can be exceedingly heavy. Double bagging of waste material is usually necessary. A determination of need for single or double bags must be made early in the abatement process and agreed to by the Owner or Owner's Agent.) Bags shall not be overfilled. They should be securely sealed to prevent accidental opening and leakage by tying tops of bags in an overhand knot or taping in goose neck fashion. Do not seal bags with wire or cord. (Bags may be placed in drums for staging and transportation to the landfill. Bags shall be decontaminated on exterior surfaces by wet cleaning and HEPA vacuuming before being placed in clean drums and sealed with locking ring tops.)

Asbestos containing waste with sharp-edged components (e.g. nails, screws, metal lath, tin sheeting) will tear the polyethylene bags and sheeting and shall be placed into fiber boxes prior to bagging or into dumpster for disposal.

After completion of all stripping work, surfaces from which asbestos containing materials have been removed shall be wet brushed and sponged or cleaned by some equivalent method to remove all visible residues. Clean up shall proceed.

3.5 CLEAN UP PROCEDURES

Remove and containerize all visible accumulation of asbestos containing material and asbestos contaminating debris utilizing rubber dust pans and rubber squeegees to move material around. Do not use metal shovels to pick up or move accumulated waste. Special care shall be taken to minimize damage to floor sheeting.

Wet clean all surfaces in the work area (including walls, floor, and ceilings) using rags, mops and sponges as appropriate. (Note: Some HEPA vacuums might not be wet-dry vacuums. To pick up excess water and gross wet debris, a wet-dry shop vacuum may be used. This will be contaminated and require cleaning prior to removal from the work area).

Remove the cleaned outer layer of plastic sheeting from walls and floors. Windows, doors, HVAC system vents and all other openings shall remain sealed. The negative pressure ventilation units shall remain in continuous operation. Decontamination enclosure systems shall remain in place and be utilized.

After cleaning the work area, wait at least 12 hours to allow fibers to settle and HEPA vacuum and wet clean all objects and surfaces in the work area again unless an applicable variance allows for alternative procedures.

Remove all containerized waste from the work area and waste container pass-out airlock.

Decontaminate all tools and equipment and remove at the appropriate time in the cleaning sequence.

Inspect the work area for visible residue. If any accumulation of residue is observed, it will be assumed to be asbestos and the 12-hour settling period/cleaning cycle repeated.

The work area shall be cleaned until it is in compliance with Federal, State and Local requirements and no visible residue is observed prior to final air sampling. Additional cleaning cycles shall be provided, as necessary until these criteria have been met.

Following the satisfactory completion of clearance air monitoring, remaining barriers may be removed and properly disposed of. A final visual inspection shall insure that no contamination remains in the work area. Unsatisfactory conditions may require additional cleaning and air monitoring.

3.6 CLEARANCE AIR MONITORING

After the removal of asbestos, the cleanup of the area shall be carried out as detailed in Industrial Code Rule 56. This shall include the applicable twelve-hour waiting periods, unless a variance allowing a shorter waiting time is applied for, received and approved by the Owner.

Final clearance of the area shall be established by analysis of air samples. Aggressive final air sampling clearance shall be performed Phase Contrast Microscopy (PCM) method of analysis in accordance with NYS ICR 56.

3.7 DISPOSAL PROCEDURES

As the work progresses, to prevent exceeding available storage capacity on site, sealed and labeled containers of asbestos containing waste shall be removed and transported to the prearranged disposal location as necessary.

All asbestos and/or asbestos contaminated waste generated both friable and/or non-friable materials must be disposed of as asbestos waste.

3.8 TRANSPORTATION PROCEDURES

Transportation and disposal of asbestos or asbestos contaminated materials must be performed in accordance with all applicable federal, state and local regulations. All dump receipts, trip tickets, transportation manifests or other documentation of disposal shall be delivered to the Building Owner or Owner's Agent for his records.

3.9 RE-ESTABLISHMENT OF WORK AREA AND SYSTEMS

Re-establishment of the work area shall only occur following the completion of clean-up procedures and after clearance air monitoring has been performed and documented to the satisfaction of the Building Owner or Owner's Agent.

Polyethylene barriers shall be removed from walls and floors at this time, maintaining decontamination enclosure systems and barriers over doors, windows, etc. as required.

3.10 TRAINING

Training shall be provided by the Contractor for all employees or Agents who may be required to disturb asbestos contaminated materials for abatement and auxiliary purposes and for all supervisory personnel who may be involved in planning, execution or inspection of abatement projects. Individuals shall be trained in accordance with but not limited to NYSDOH Title 10 Part 73.

Training shall provide, at a minimum, information on the following topics.

The health hazards of asbestos including the nature of various asbestos related diseases, routes of exposure, known dose-response relationships, the synergistic relationship between asbestos exposure and cigarette smoking, latency periods for disease and health basis for standards.

The physical characteristics of asbestos including fiber size, aerodynamic properties, physical appearance and uses.

Employee personal protective equipment including the types and characteristic of respirators, field testing the face-piece to face seal (positive and negative pressure fitting tests), qualitative

and quantitative fit testing procedures, variations between laboratory and field fit factors, factors that affect respirator fit (e.g. facial hair), selection and use of disposable clothing, use and handling of launderable clothing, non-skid shoes, gloves, eye protection and hard hats.

Medical monitoring requirements for workers including required and recommended tests, reasons for medical monitoring and employee access to records.

Air monitoring procedures and requirements for workers including description of equipment and procedures, reasons for monitoring, types of samples and current standards with recommended changes.

Work practices for asbestos abatement including purpose, proper construction and maintenance of air-tight plastic barriers, job set-up of air locks, worker decontamination systems and waste transfer air locks, posting of warning signs, engineering controls, electrical and ventilation system lockout, proper working techniques, waste clean-up, storage and disposal procedures.

Personal hygiene including entry and exit procedures for the work area, use of showers and prohibition of eating, drinking, smoking, chewing and contact lenses in the work area.

Special safety hazards that may be encountered including electrical hazards, air contaminants (CO, wetting Agents, encapsulant, materials from Owner or Owner's Agent operation), fire and explosion hazards, scaffold and ladder hazards, slippery surfaces, confined spaces, heat stress and noise.

Workshops affording both supervisory personnel and abatement workers the opportunity to see (and experience) the construction of containment barriers and decontamination facilities.

Supervisory personnel shall, in addition, receive training on contract specifications, liability insurance and bonding, legal considerations related to abatement, establishing respiratory protection medical surveillance programs, EPA and OSHA record keeping requirements as requested by the Owner or Owner's Agent.

Training is to have occurred within 12 months prior to the initiation of abatement activities.

Contractor must document training by providing the Owner or Owner's Agent with such documentation including date of training, training entity, duration of the training, course outline, and names and qualifications of trainers.

3.11 MEDICAL MONITORING

Medical Monitoring must be provided by the Contractor to any employee or Agent that may be exposed to asbestos in excess of background levels during any phase of the abatement project. (Due to the synergistic effects between smoking and asbestos exposure, it is highly recommended that only non-smokers be employed in positions which require them to enter asbestos contaminated atmospheres.

Medical monitoring shall include at a minimum:

A work/medical history to elicit symptomatology of respiratory disease.

A chest x-ray (posterior - anterior, 14 by 13 inches) evaluated by a Certified B-reader.

A pulmonary function test, including forced vital capacity (FVC) and forced expiratory volume at one second (FEV)1, administered and interpreted by a Certified Pulmonary Specialist.

Employees shall be given an opportunity to be evaluated by a physician to determine their capability to work safely while breathing through the added resistance of a respirator. (Examining physicians shall be aware of the nature of respiratory protective devices and their contributions to breathing resistance. They shall also be informed of the specific types of respirators the employee shall be required to wear and the work the employee will be required to perform, as well as special workplace conditions such as high temperatures, high humidity, and chemical contaminant exposure).

3.12 AIR SAMPLING TECHNICIAN

The Owner will be responsible for retaining the services of an independent third-party air monitoring firm to perform and fulfill the air monitoring requirement in accordance with NYS ICR 56.

Air sampling must be performed throughout the project in accordance with NYS ICR 56. The persons performing the air sampling must be a NYS DOL certified air sampling technician working for a NYS DOL licensed air monitoring firm. The air sampling shall include, but is not limited to, background sampling, preparatory sampling, during abatement sampling and clearance sampling as required in NYS ICR 56 or applicable variances.

3.13 LABORATORY SERVICES

Laboratories utilized for analyzing air samples by NIOSH 7400 method shall be certified under the New York State Environmental Laboratory Approval Program (ELAP). Laboratories used for analyzing air samples by Transmission Electron Microscopy (TEM) shall be satisfactory participants in and be certified under the National Voluntary Laboratory Accreditation Program (NVLAP). Laboratories used for bulk material identification shall be satisfactory participants in the EPA quality assurance program for bulk asbestos analysis and certified by both the ELAP and NVLAP.

The Owner shall be responsible for retaining the services of an independent testing laboratory to perform and fulfill the air sampling analysis requirements in accordance with NYS ICR 56, OSHA and ELAP. The costs associated with the laboratory analysis services shall be included in the unit prices bid for the work described in these specifications. The testing laboratory must be approved by the Owner or Owner's Agent.

For PCM and TEM analysis the period of time permitted between the collection of air samples and the availability of verbal results shall be 24 hours or less.

3.14 DEFINITIONS

Abatement: Procedures to control fiber release from asbestos-containing materials. Includes removal, encapsulation, enclosure, repair, demolition and renovation activities.

Airlock: System for permitting ingress and egress with minimum air movement between a contaminated area and an uncontaminated area, typically consisting of two curtained doorways separated by a distance of at least three (3) feet such that one passes through one doorway into the airlock, allowing the doorway sheeting to overlap and close off the opening before proceeding through the second doorway, thereby preventing flow-through contamination.

Air monitoring: The process of measuring the fiber content of a known volume of air collected during a specific period of time. The procedure normally utilized for asbestos follows the NIOSH Standard Analytical Method for Asbestos in Air Method 7400. Electron microscopy methods may be utilized for detecting smaller fibers and specific fiber identification.

Air Sampling Professional: The professional contracted by the Building Owner or Owner's Agent or by the Contractor to review and/or conduct air monitoring and analysis schemes. Air sampling, review and evaluation of results should be performed by an individual certified the New York State Department of Labor and Department of Health in air sampling for asbestos.

Amended Water: Water to which a surfactant has been added.

ANSI: American National Standards Institute

Asbestos: The asbestiform varieties of serpentine (chrysotile), riebeckite (crocidolite), cummingtonite-grunerite (amosite), anthophyllite, actinolite, and tremolite.

Asbestos Containing Material (ACM): Material composed of asbestos of any type either alone or mixed with other fibrous or non-fibrous materials.

Asbestos Containing Waste Material: Asbestos containing material or asbestos contaminated objects requiring disposal.

Asbestos Project Monitor/Manager: An individual, other than an asbestos abatement Contractor or an employee or Agent thereof, designated as the Owners representative and responsible for overseeing the asbestos abatement project. The Project Monitor shall possess a valid project monitor certificate from the NYS DOL and shall have such certificate or copy thereof in his/her possession at all times while working on the project.

ASTM: American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103
Authorized visitor: The Building Owner or Owner's Agent (and any designated representative) and any representative of a regulatory or other agency having jurisdiction over the project.

Building Owner or Owner's Agent: The Owner or his authorized representative.

Certified Persons: Persons maintaining current certifications from the NYSDOL and DOH and any other government agency having jurisdiction over the project, for the specific task for which he/she is expected to perform (i.e. Supervisor, Asbestos Handler, Air Monitor, etc...).

Clean Room: An uncontaminated area or room which is part of the worker decontamination enclosure system with provisions for storage of worker's street clothes and clean protective equipment.

Contractor: Asbestos abatement Contractor.

Curtained Doorway: A device to allow ingress or egress from one room to another while permitting minimal air movement between the rooms, typically constructed by placing three overlapping sheets of plastic over an existing or temporarily framed doorway, securing each along the top of the doorway, and along opposite vertical sides of the doorway.

Decontamination Enclosure System: A series of connected rooms, separated from the work area and from each other by air locks, for the decontamination of workers and equipment.

Demolition: The wrecking or taking out of any load- supporting structural member of a facility together with any related handling operations.

Encapsulant: A liquid material which can be applied to asbestos containing material which controls the possible release of asbestos fibers from the material either by creating a membrane over the surface (bridging encapsulant) or by penetrating into the material and binding its components together (penetrating encapsulant).

Encapsulation: The application of an encapsulant to asbestos containing materials to control the release of asbestos fibers into the air.

Enclosure: The construction of an air-tight, impermeable, permanent barrier around asbestos containing material to control the release of asbestos fibers into the air.

EPA: U.S Environmental Protection Agency, 401 M Street S.W., Washington, DC 20460.

EPA: Title 40 CFR Part 61

Equipment Room: A contaminated area or room which is part of the worker decontamination enclosure system with provisions for storage of contaminated clothing and equipment.

Facility: Any institutional, commercial or industrial structure, installation or building.

Facility Component: Any pipe, duct, boiler, tank, reactor, turbine or furnace at or in a facility or any structural member of a facility

Friable Asbestos: Asbestos containing material which can be crumbled to dust, when dry, under

hand pressure.

Glovebag Technique: A method for removing small amounts of material from HVAC ducts, short piping runs, valves, joints, elbows, and other surfaces. The glovebag is constructed and installed in such a manner that it surrounds the object or material to be removed and contains all asbestos fibers released during the process.

Ground Fault Circuit Interrupter: A circuit breaker that is sensitive to very low levels of current leakage from a fault in an electrical system.

HVAC: Heating, ventilation and air conditioning system.

HEPA Filter: A high efficiency particulate air filter capable of removing particles greater than 0.3 microns in diameter with 99.97% efficiency.

HEPA Vacuum: A vacuum system equipped with HEPA filtration.

Holding Area: A chamber in the equipment decontamination enclosure located between the washroom and an uncontaminated area. The holding area is comprised of an airlock.

Negative Pressure Ventilation System: A portable exhaust system equipped with HEPA filtration and capable of maintaining a constant low velocity air flow into contaminated areas from adjacent uncontaminated areas.

NESHAPS: The National Emission Standards for Hazardous Air Pollutants (40 CFR Part 61).

NYDEC: New York State Department of Environmental Conservation; Title 6 Part 264

NYS DOL: New York State Department of Labor

NYS DOH: New York State Department of Health; Title 10 Part 73

NYS ICR 56: New York State Industrial Code Rule 56

NIOSH: The National Institute for Occupational Safety and Health, CDC - NIOSH, Building J N.E. Room 3007, Atlanta, Georgia 30333.

OSHA: The Occupational Safety and Health Administration, 200 Constitution Avenue, Washington, D.C. 20210.

OSHA: Title 29 CFR Part 1910

Owner: The Owner or managing Agent of the building. The Owner's Agent is any entity that the Owner has appointed as their representative.

Plasticize: To cover floors and walls with plastic sheeting as herein specified.

Renovation: Altering in any way one or more facility components. Operations in which load-supporting structural members are wrecked or taken out are excluded.

Shower Room: A room between the clean room and the equipment room in the worker decontamination enclosure with hot and cold or warm running water controllable at the tap and suitably arranged for a complete shower during decontamination. There shall be an airlock at both the entrance and exit of the shower room.

Staging area: Either the holding area or some area near the waste transfer airlock where containerized asbestos waste has been placed prior to removal from the work area.

Surfactant: A chemical wetting Agent added to water to improve penetration.

Visible Emissions: Any emissions containing particulate material that are visually detectable without the aid of instruments. This does not include condensed uncombined water vapor.

Waste Transfer Airlock: A decontamination system utilized for transferring containerized waste from inside to outside of the work area.

Wet cleaning: The process of eliminating asbestos contamination from building surfaces and objects by using cloths, mops, or other cleaning utensils which have been dampened with water and afterwards thoroughly decontaminated or disposed of as asbestos contaminated waste.

Worker Decontamination Enclosure: A decontamination system consisting of a clean room, a shower room, and an equipment room separated from each other and from the work area air locks and contained doorways. This system is used for all worker entries and exits in the work area and for passing out equipment and waste for small jobs.

NOTE: Whenever a conflict exists between one of the above referenced definitions and that from any other applicable regulation or source the most stringent shall apply. The final interpretation must be approved by the Owner.

END OF SECTION 028200

SECTION 030131

CONCRETE REHABILITATION

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Crack Repairs by Epoxy Injection: Section 030132.

1.02 REFERENCES

- A. Except as shown or specified, the Work of this Section shall conform to the requirements of International Concrete Repair Institute (ICRI), 3166 S. River Rd., Suite 132, Des Plaines, IL 60018, (847) 827-0830, www.icri.org.
 - 1. ICRI Guideline No. 310.1R-2008 Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion (formerly Guideline No. 03730).

1.03 SUBMITTALS

- A. Product Data: Manufacturer's specifications and installation instructions for factory packaged products.

1.04 QUALITY ASSURANCE

- A. Field Examples: Prior to performing the Work of this Section, prepare a sample panel, or a portion of existing concrete which is to be repaired, to represent each type of rehabilitation work required. Approved samples will be used as quality standards for the Work. Maintain approved samples at the site until the Work is completed.
- B. Material Container Labels: Material containers shall bear the manufacturer's label indicating manufacturer's name, trade name of product, lot number, shelf life of product, and mix ratio (if applicable).

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the site in original, sealed containers. Do not deliver materials that have exceeded shelf life limitation set forth by the manufacturer.
- B. Comply with manufacturer's printed instructions for storing and handling materials.

1.06 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with the product manufacturer's printed limitations and instructions.

PART 2 PRODUCTS

2.01 COMPANIES

- A. The Euclid Chemical Company, 19218 Redwood Rd., Cleveland, OH 44110-2799, (800) 321-7628, www.euclidchemical.com.
- B. Sika Corporation, 201 Polito Ave., Lyndhurst, NJ 07071, (800) 933-7452, www.sikausa.com.
- C. Kaufman Products, Inc., 3811 Curtis Ave., Baltimore, MD 21226, (800) 637-6372, www.kaufmanproducts.net.
- D. L&M Construction Chemicals, Inc., 14851 Calhoun Rd., Omaha, NE 68152, (800) 362-3331, www.lmcc.com.
- E. Conproco Corp., 17 Production Dr., Dover, NH 03820, (800) 258-3500, www.conproco.com.
- F. BASF Building Systems, 889 Valley Park Dr., Shakopee, MN 55379, (800) 433-9517, www.buildingsystems.basf.com.

2.02 MATERIALS

- A. The following brand names are specified to establish product generic type and standard of quality. Other comparable products in the manufacturer's same product series may be required to closely fit the particular job conditions. Use appropriate product for depth of patch and temperature at time of application. More than one product may be required for a particular type of patching mortar. When a color choice is available, select the color to match adjoining concrete as closely as practicable. A bonding agent/primer and/or sealer shall be used as recommended by the patching mortar manufacturer.
- B. Cement/Acrylic/Latex Base Patching Mortars:
 - 1. Type C-1 Patching Mortar: "Verticoat", by The Euclid Chemical Company; "SikaTop 122 Plus" or "SikaTop 123 Plus" by Sika Corp; "Patchwell VO" or "HiCap Plus" by Kaufman Products, Inc.
 - 2. Type C-2 Patching Mortar: "SikaTop 121 Plus", "SikaTop 122 Plus" or "SikaTop 111 Plus" by Sika Corp.; "Patchwell Kit", "Patchwell Deep", "SureFlow 040", or "SureFlow 042" by Kaufman Products, Inc.; "Thincoat" or "Concrete Coat" by The Euclid Chemical Company;
 - 3. Type C-3 Patching Mortar: "Patchwell VO", "HiCap", "HiCap Plus" or "DressUp" by Kaufman Products, Inc.; "SikaTop 123 Plus" or "SikaTop 144" by Sika Corp.; or "Verticoat Supreme" by The Euclid Chemical Company.
- C. Epoxy Base Patching Mortars:
 - 1. Type E-1 Patching Mortar: 100 percent solids, low modulus, low viscosity, moisture insensitive, epoxy resin and aggregate system; "Sikadur 21 Lo-Mod LV" by Sika Corporation; "Flexocrete Epoxy

- System”by The Euclid Chemical Company; “SurePoxylMLV” by Kaufman Products, Inc.
 - 2. Type E-2 Patching Mortar: 100 percent solids, low modulus, high viscosity, moisture insensitive, epoxy resin and aggregate system; “Sikadur 23 Lo-Mod Gel” by Sika Corporation; “Flexocrete Gel” by The Euclid Chemical Company; “SurePoxylLM Gel” by Kaufman Products, Inc.;
 - 3. Type E-3 Patching Mortar: High modulus, medium/low viscosity, moisture insensitive, epoxy resin and aggregate system; “Sikadur 35” or “Sikadur 62” by Sika Corporation, “Duralcrete” by The Euclid Chemical Company or “SurePoxylHM”, “SurePoxylHM, Class B”, “SurePoxylHMLV”, “SurePoxylHMLV, Class B”, “SurePoxylHMSLV”, “SurePoxylHiBilD” by Kaufman Products, Inc.
 - 4. Type E-4 Patching Mortar: High modulus, high viscosity, moisture insensitive, epoxy resin and aggregate system; “Sikadur 31 Hi-Mod Gel” or “Sikadur 31 Hi-Mod Gel SBA Slow Set” by Sika Corporation; “Duralcrete Gel” by The Euclid Chemical Company; or “SurePoxylHM Gel”, or “SurePoxyl117” by Kaufman Products, Inc.
 - 5. Aggregate: As recommended by the patching mortar manufacturer for the binder and application.
- D. Rapid-hardening Cementitious Patching Mortar:
- 1. Type R-1 Patching Mortar: “Durapatch” by L&M Construction Chemicals, Inc.; or “SikaSet Roadway Patch” by Sika Corp or “Duracrete II”, “Duracrete II HW”, “Duracrete II FR”, Duracrete II HWFR”, by Kaufman Products, Inc.;
- E. Rebar Coating: “SurePoxylHMEPL” or SurePoxylHM 12” by Kaufman Products, Inc.; “ECB” by Conproco Corp.; or “Emaco P22” or “Emaco P24” by BASF Building Systems.
- F. Cleaning Agent, Bonding Agent/Primer, Sealer/Topcoat: As recommended by the patching mortar manufacturer, including primer for the reinforcing steel and primer for the concrete substrate.
- G. Concrete and Bonding Agent (for concrete): Normal weight cast-in-place concrete and adhesive bonding agent as specified in Section 033000 or 033001.
- H. Accessories:

PART 3 EXECUTION

3.01 PREPARATION

- A. Protection: Cover or otherwise protect adjacent surfaces not being repaired.
- B. Surface Preparation:
 - 1. Prepare surfaces to be repaired in accordance with the product manufacturer’s printed instructions and as specified.

2. Cut out and remove cracked, spalled, and disintegrated concrete. Cut back to sound concrete. Cut edges of patch perpendicular to surface of patch, unless otherwise recommended by mortar manufacturer. If steel reinforcing bars are exposed, chip concrete out from behind exposed length of bars as required for a minimum clearance around circumference of bar of 3/4 inch. In addition, cut a minimum one inch length of sound concrete away from each end of exposed length of reinforcing bars.
3. Clean exposed steel reinforcement; remove bits of concrete and loose rust. If reinforcement is bowed out toward surface of the concrete, bend reinforcement back from surface.
4. Remove paint, oils, grease, dirt, salt deposits, laitance and other contaminants from surfaces to be patched. Use cleaning agent where required.
5. Clean areas to be patched with oil-free air or water under pressure, except as otherwise recommended by the mortar manufacturer.

3.02 COATING REBAR

- A. Coat reinforcing as soon as possible after completion of surface preparation.
- B. Place reinforcement coating complying with manufacturers printed instructions.

3.03 PATCHING CONCRETE

- A. Patch concrete as soon as possible after completion of surface preparation.
- B. Mixing Patching Mortar: Comply with mortar manufacturer's printed instructions. Proportion components and sizes of aggregate as recommended by mortar manufacturer for the particular job conditions.
- C. Patch concrete in accordance with the product manufacturer's printed instructions.
 1. Coat contact surfaces of existing concrete and steel reinforcing with a bonding agent/primer as recommended in the product manufacturer's instructions.
- D. Bring patches out to the original surfaces in true planes. Finish patches to match texture of adjoining concrete as close as possible.
- E. Cure patches in accordance with the product manufacturer's printed instructions.

3.04 CLEANING

- A. Clean up spatters and droppings.

3.05 PROTECTION

- A. Protect mortar after placement in accordance with the product manufacturer's printed instructions.

END OF SECTION

SECTION 030132

CRACK REPAIRS BY EPOXY INJECTION (As Applicable)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Structural repair of cracks in concrete by permanently rebonding the concrete with epoxy resin adhesive injected under pressure with special equipment.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Concrete Rehabilitation: Section 030131.

1.03 PERFORMANCE REQUIREMENTS

- A. Seepage of water through cracks repaired under the Work of this Section will be regarded as defective Work subject to the one year guarantee required by the General Conditions.

1.04 SUBMITTALS

- A. Product Data: Manufacturer's printed specifications and installation instructions for epoxy adhesive and surface seal material.
- B. Quality Control Submittals:
 - 1. Test Reports:
 - a. Submit reports for tests specified under Source Quality Control.
 - b. If requested, submit test reports for all specified characteristics and properties of the epoxy adhesive materials from an Independent Testing Laboratory.
 - 2. Certificates: Epoxy adhesive manufacturer's written certification that each batch of epoxy adhesive material shipped for this Project complies with the requirements of these specifications.

1.05 QUALITY ASSURANCE

- A. Installer's Qualifications: Epoxy injection shall be performed by a firm that is licensed or approved by the epoxy adhesive manufacturer to perform such work. In addition, the person supervising the epoxy injection shall be experienced in epoxy injection, and shall have been regularly employed for a minimum of five years by a company specializing in repairing cracks by epoxy injection.
 - 1. If requested, furnish to the Director the names and addresses of five similar projects for which the supervisor has supervised epoxy injection work.
- B. Workers' Qualifications: Workers engaged in the Work of this Section shall have satisfactorily completed a program of instruction in the epoxy injection process. The instruction shall include this specific method of repairing cracks in

concrete, the technical aspects of correct material use, and the operation, maintenance and checking of equipment.

- C. Testing Agency: Tests for all specified characteristics and properties of the epoxy adhesive materials shall have been performed by a qualified Independent Testing Laboratory and copies of the test results shall be available. Tests indicated under Source Quality Control shall be performed by the adhesive manufacturer.
- D. Source Quality Control: The following quality control tests shall be performed on each lot of epoxy adhesive materials supplied for this Project. Tests shall be conducted using the test methods indicated in Part 2.
 - 1. Resin viscosity at 77 degrees F and epoxide equivalent weight.
 - 2. Hardener viscosity at 77 degrees F and amine value.
 - 3. Combined components pot life at 77 degrees F.
 - 4. Cured (for 7 days) adhesive ultimate tensile strength and tensile elongation at break; and slant shear strength for wet/wet concrete cured 3 days.
- E. Material Container Labels: Material containers shall bear a manufacturer's label indicating manufacturer's name, trade name of product, lot number, shelf life of product, and mix ratio by volume.
- F. Equipment for Injection: The injection equipment shall meter and mix the adhesive components, and inject the mixed adhesive into the cracks. Equipment shall be a portable, positive displacement type pump unit with interlock to insure exact ratio control of the two components at the nozzle. Unit shall have metering pumps, electrically or air powered, which will provide in-line metering and mixing of the adhesive components.
 - 1. Discharge Pressure: The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 psi (within a tolerance of plus or minus 5 psi), and shall be equipped with a manual pressure control override.
 - 2. Ratio Tolerance: The injection equipment shall have the capability of maintaining the volume ratio for the adhesive, as prescribed by the manufacturer of the adhesive, within a tolerance of plus or minus 5 percent by volume at any discharge pressure up to 200 psi.
 - 3. Automatic Shut-Off Control: The injection equipment shall have sensors on both component reservoirs that will automatically stop the machine when only one component is being pumped to the mixing head.

1.06 DELIVERY AND STORAGE

- A. Deliver materials to the site in original, sealed containers bearing manufacturer's label. Do not deliver materials which have exceeded shelf life limitation set forth by the manufacturer.
- B. Comply with manufacturer's printed instructions for storing materials in original, sealed containers at a temperature between 32 degrees F and 90 degrees F.

1.07 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with manufacturer's recommendations for conditions under which materials can be applied.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Epoxy Adhesive: Two component, low viscosity, epoxy resin adhesive system containing 100 percent solids, with no solvents or non-reactive diluents, which meets the following characteristics and properties:
1. Resin: Blend of epoxy resins.
 - a. Viscosity at 40 + 3 degrees F, cps (Brookfield RVT Spindle No. 4 at 20 rpm): 6,000 - 8,000.
 - b. Viscosity at 77 + 3 degrees F, cps (Brookfield RVT Spindle No. 2 at 20 rpm): 300 - 700.
 - c. Epoxide Equivalent Weight (ASTM D 1652): 160 - 220.
 - d. Ash Content, percent (ASTM D 482): 1 maximum.
 2. Hardener: Blend of amine curing agents.
 - a. Viscosity at 40 + 3 degrees F, cps (Brookfield RVT Spindle No. 2 at 20 rpm): 700 - 1,400.
 - b. Viscosity at 77 + 3 degrees F, cps (Brookfield RVT Spindle No. 2 at 20 rpm): 100 - 400.
 - c. Amine Value, mg KOH/g (ASTM D 664): 490 - 560.
 - d. Ash Content, percent (ASTM D 482): 1 maximum.
 3. Pot Life of the Combined Components: When mixed in the ratio recommended by the manufacturer for use, material shall have pot life as follows:
 - a. 60 g at 77 + 3 degrees F: 13 - 55 minutes.
 4. Properties of the Cured Adhesive: When cured for 7 days at 77 + 3 degrees F, material shall have the following properties:
 - a. Ultimate Tensile Strength, psi (ASTM D 638): 5,000 minimum.
 - b. Tensile Elongation at Break, percent (ASTM D 638): 4 maximum.
 - c. Flexural Strength, psi (ASTM D 790): 10,000 minimum.
 - d. Compressive Yield Strength, psi (ASTM D 695): 10,000 minimum.
 - e. Slant Shear Strength, psi (AASHTO T 237, 5,000 psi compressive strength concrete):
 - 1) Cured 3 days at 40 + 3 degrees F, wet/wet concrete: 3,500 minimum.
 - 2) Cured 7 days at 40 + 3 degrees F, wet/wet concrete: 4,000 minimum.
 - 3) Cured 1 day at 77 + 3 degrees F, dry/dry concrete: 5,000 minimum.

NOTE: Minor modifications to the indicated test methods, which are standard industry procedures for testing epoxy adhesives, may be made. Test reports shall indicate such modifications.

- B. Surface Seal: Material with adequate strength and adhesion to hold injection fittings firmly in place and to prevent leakage of epoxy adhesive during injection, and removable without damaging or defacing structure being repaired.
- C. Finishing Patching Materials: As required to match color, texture, and performance of adjoining surfaces as closely as practicable.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean cracks and adjacent surfaces free of loose material, dust, dirt, grease, oil, efflorescence, and other foreign matter in accordance with epoxy adhesive manufacturer's printed instructions and as required for proper bonding of surface seal. Do not use acids or corrosives.
- B. Establish entry ports along each crack spaced at intervals not less than the thickness of the concrete member being repaired.
- C. Apply surface seal material to the face of each crack between the entry ports as required to prevent escape of injected epoxy adhesive. For cracks all the way through the concrete member, apply surface seal to both faces of cracks where accessible. Allow sufficient time for the surface seal material to gain adequate strength before proceeding with epoxy injection.
- D. If cracks extend into moving joints, plug or seal off the cracks at the joints.

3.02 EPOXY INJECTION

- A. Set up and check injection equipment and material in accordance with the manufacturer's instructions and as specified. Do not thin epoxy adhesive.
- B. Beginning at the lowest entry port in the crack, unless otherwise recommended by the installer because of the configuration of the crack, inject epoxy adhesive in the entry port until there is an appearance of adhesive at the next adjacent entry port. When epoxy adhesive travel is indicated at the next adjacent port, discontinue injection in the port, seal off the port, and resume injection in the next adjacent port. Continue this procedure until the crack has been injected full of epoxy adhesive for its entire length in one continuous operation. For horizontal cracks, proceed from one end of the crack to the other end in the same manner. Seal the last port, and allow the adhesive to cure.
- C. If port to port travel of epoxy adhesive does not result after a reasonable amount of pumping, stop injecting adhesive. Report abnormal conditions (if any) immediately to the Director's Representative.

3.03 FINISHING

- A. Remove surface seal and entry port fittings when epoxy adhesive has sufficiently cured to allow removal without disturbing the adhesive.

- B. Fill the face of the crack out flush with the concrete surface plane with patching materials. Eliminate indentations and evidence of port fittings. Finish patches to match texture of adjoining concrete surface as closely as practicable.

3.04 FIELD QUALITY CONTROL

- A. Furnish equipment necessary to perform field testing.
- B. Pressure Test: The mixing head of the injection equipment shall be disconnected and the two supply lines shall be attached to a pressure check device. The pressure check device shall consist of two independently valved nozzles capable of controlling flow rate and pressure by opening or closing the valve. There shall be a pressure gauge capable of sensing the pressure build-up behind each valve. The valves on the pressure check device shall be closed and the injection equipment operated until the gauge pressure on each line reads 190 psi. The pumps shall be stopped and the gauge pressure shall not drop below 180 psi within 3 minutes.
- C. Ratio Tests: The mixing head of the injection equipment shall be disconnected and the two adhesive components shall be pumped simultaneously through a ratio check device. The ratio check device shall consist of two independently valved nozzles capable of controlling back pressure by opening or closing the valve. There shall be a pressure gauge capable of sensing the back pressure behind each valve. The discharge pressure shall be adjusted to 180 psi for both adhesive components, and then the components shall be simultaneously discharged into separate calibrated containers. The amounts discharged into the containers during the same time period shall be compared to determine the volumes and the ratio of the components. The test shall be repeated with the discharge pressure adjusted to 0 psi for both adhesive components.
- D. Frequency of Pressure and Ratio Tests: A pressure test and ratio tests shall be performed for each injection equipment unit at the beginning of each shift and after the meal break of each shift that the unit is used.
 - 1. Perform additional tests when directed by the Director's Representative.
- E. Records of Tests: Record the date and results of all tests, and furnish a copy of the test records to the Director's Representative.

3.05 CLEANING

- A. Remove adhesive runs and spills from existing surfaces by a method which will not deface the surfaces being cleaned.

END OF SECTION

SECTION 031100

CONCRETE FORMWORK

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Steel Concrete Reinforcement: Section 032100.
- B. Cast-In-Place Concrete: Section 033000.

1.02 REFERENCES

- A. Except as shown or specified otherwise, the Work of this Section shall conform to the requirements of Specifications for Structural Concrete for Buildings ACI 301-99 of the American Concrete Institute.

1.03 DESIGN REQUIREMENTS

- A. ACI 301, Section 2.1 – Formwork and formwork accessories, General:
 - 1. Add the following to 2.1.1 Description:

The formwork shall be designed for loads, lateral pressure, and allowable stresses outlined in Chapter 2 - Design of “Guide to Formwork for Concrete” (ACI 347-01).
- B. Design Calculations and Drawings: Forms, including shores and reshores, shall be designed by a professional engineer licensed to practice in New York State. The engineer’s calculations and drawings shall be signed and sealed by the engineer and kept on the job. Formwork shall be constructed in accordance with the engineer’s signed and sealed drawings.

1.04 SUBMITTALS

- A. Shop Drawings:
- B. Product Data: Manufacturer’s catalog sheets, specifications, and installation/application instructions for the following:
 - 1. Form systems and ties.
 - 2. Textured (architectural) form linings.
- C. Samples:
 - 1. Textured (Architectural) Form Lining: 2 feet square section, each type.
 - 2. Rustication Strip: 1 foot long section, each profile.

1.05 QUALITY ASSURANCE

- A. Field Examples: Provide formwork for mock-up of cast-in-place concrete. Construct forms using facing materials required to provide specified finishes and textures. Do not proceed with structure formwork until sample panels and forms have been approved by the Director in writing.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Chamfer Strips: Wood, metal, PVC or rubber; 1 inch chamfer, unless otherwise indicated on the Drawings.
- B. Rustication Strips: As required to provide rustication, patterns and profiles indicated on the Drawings.
- C. Facing for Exposed Textured Finish Concrete Surfaces:

PART 3 EXECUTION

3.01 PREPARATION OF FORM SURFACES

- A. Apply form-coating material in accordance with manufacturer's instructions.

3.02 INSTALLATION

- A. Provide chamfer on all exposed external corners of concrete.
- B. Provisions for Work of Related Contracts: Provide openings in concrete formwork to accommodate Work of related contracts. Obtain information for size and location of openings, recesses and chases from contractor requiring such items.
- C. Shores and Supports:
 - 1. Concrete members subject to additional loads during construction shall be shored in such a manner as will protect the member from damage by the loads.
 - 2. Place shores supporting successive stories directly over those below or so design the shores to transmit the load directly to them.
 - 3. Do not remove shores until the member supported has acquired sufficient strength to safely support its weight and any weight imposed thereon.

3.03 REMOVAL OF FORMS

- A. ACI 301, Section 2.3.2 - Removal of Forms:
 - 1. Change paragraph 2.3.2.5 to read as follows:

2.3.2.5 Forms and shoring used to support the weight of concrete in beams, slabs and other structural members shall be removed in accordance with recommendations in paragraph 3.7.2.1 of Article 3.7 -

Removal of Forms and Supports of “Recommended Practice for Concrete Formwork” (ACI 347-01).

2. Add the following paragraphs:

2.3.2.7 All formwork shall be removed after the concrete has sufficiently hardened, except in inaccessible spaces where approved.

2.3.2.8 After the ends or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 3/4 inch from the formed surfaces of concrete.

3.04 RE-USE OF FORMS

- A. Split, frayed, delaminated or otherwise damaged form facing material shall not be used.

END OF SECTION

SECTION 032100

STEEL CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Concrete Formwork: Section 031100.
- B. Cast-In-Place Concrete: Section 033000.

1.02 REFERENCES

- A. Except as shown or specified otherwise, the Work of this Section shall conform to the applicable requirements of the following:
 - 1. Specifications for Structural Concrete, ACI 301-99 of the American Concrete Institute.
 - 2. Manual of Standard Practice, MSP-1-01 of the Concrete Reinforcing Steel Institute.

1.03 SUBMITTALS

- A. Shop Drawings: Placing drawings for bar reinforcement.
- B. Samples:
 - 1. Bar Supports: Full size.
 - 2. Fabric Reinforcement: 8 inches square, each wire size.
 - 3. Fabric Reinforcement Supports: 3'-0" long pieces.
 - 4. Reed Clips: 2'-6" long pieces.
- C. Quality Control Submittals:
 - 1. Certificates: Affidavit required under Quality Assurance Article.
- D. LEED Design Submittals:
 - 1. MR Credit 4.1 and MR Credit 4.2: Identify manufacturer's name, the percentage of post-consumer recycled content by weight, the pre-consumer recycled content by weight, and the cost of the product.
 - 2. MR Credit 5.1 and MR Credit 5.2: Identify source, cost, and the fraction by weight that is considered regional.

1.04 QUALITY ASSURANCE

- A. Certifications: Affidavit by the bar reinforcement manufacturer certifying that bar material meets the contract requirements.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Bar Reinforcement: ASTM A 615, Grade 60, deformed steel bars.
- B. Fabric Reinforcement: ASTM A 185, welded wire fabric, fabricated into flat sheets unless otherwise indicated.
- C. Bar Supports; Either of the Following Types:
 - 1. Galvanized steel or AISI Type 430 stainless steel, and without plastic tips.
 - 2. Insoluble plastic, with minimum 1,500 psi tensile strength and capable of retaining fabricated shape at temperatures between 5 degrees F and 170 degrees F.
- D. Fabric Reinforcement Supports:
 - 1. Uni Zag by Universal Form Clamp, 840 South 25th Avenue, Bellwood, IL 60104, (800)728-1958.
 - 2. Continuous Support, "CS" by Dayton Superior, 721 Richard Street, Miamisburg, OH 45342, (800) 745-3700.
- E. Tie Wire: Black annealed wire, 16-1/2 gage or heavier.
- F. Steel Wire: ASTM A 82, cold-drawn plain steel wire, size No. W2.9 unless otherwise indicated.
- G. Reed Clips: ASTM A 185, rigid type reed clips, fabricated of W1.4 steel cross wires spaced 12 inches apart and looped at edges of flanges, and W1.4 longitudinal wire. Reinforcement shall have two longitudinal wires for flanges 9 inches to 15 inches in width, and three longitudinal wires for flanges over 15 inches in width. Cross wires shall be welded to longitudinal wire(s).

PART 3 EXECUTION

3.01 PLACING

- A. ACI 301, Section 3.3 Execution:
 - 1. Replace the first sentence in paragraph 3.3.2.1 Tolerances- with the following:

Place, support, and fasten reinforcement as shown on the project drawing or approved shop submittal.
 - 2. Add the following paragraphs:

3.3.2.1.a At the time concrete is placed, reinforcement shall be free of loose rust and loose mill scale.

3.3.2.4.j Bar Reinforcement: In rectangular panels of two-way construction, place the steel in the short direction first with the longer bars on top in the opposite direction.

3.3.2.5.a Fabric Reinforcement: Offset end laps in adjacent sheets to prevent continuous joints at ends of sheets.

In concrete slabs supported by steel joists, place fabric reinforcement approximately 3/4 inch below top surface of the concrete.

Support of Fabric Reinforcement, provide Fabric Reinforcement Supports tied to fabric at 18 inches o.c. and spaced at 36-inch intervals.

3.3.2.11 Fireproofing Reinforcement: Unless otherwise indicated, install reinforcement for concrete fireproofing as follows:

3.3.2.11.a Reinforce concrete flange encasement of steel beams, girders, and columns with reed clips when the flanges are more than 3 inches in width and the thickness of concrete encasement on such flanges is less than 3 inches.

3.3.2.11.b Where the bottom of the concrete encasement on lower flange of steel beams and girders is 12 inches or more below the soffit of adjacent concrete slab, and where no slab occurs, wrap the beams and girders with steel wire at intervals of 12 inches, in addition to the reed clips.

3.02 SCHEDULE

A. Unless other reinforcing is shown on the Drawings, reinforce the following items of concrete as indicated below:

1. Concrete Slabs on Grade: 6 x 6 - W2.9 x W2.9 welded wire fabric.
2. Concrete Floor Fills 2-1/2 Inches Thick or Less: 6 x 6 - W2.1 x W2.1 welded wire fabric.
3. Concrete Floor Fills Greater than 2-1/2 Inches Thick: 6 x 6 - W4 x W4 welded wire fabric.
4. Concrete Slabs Supported by Steel Joists: 6 x 6 - W2.1 x W2.1 welded wire fabric.

END OF SECTION

SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Concrete Walks: Section 321300.
- B. Concrete Formwork: Section 031100.
- C. Steel Concrete Reinforcement: Section 032100.

1.02 REFERENCES

- A. Except as shown or specified otherwise, the Work of this Section shall conform to the requirements of American Concrete Institute (ACI) and American Society for Testing and Materials (ASTM) documents.
 - 1. ACI 301-05: Specification for Structural Concrete for Buildings.
 - 2. ACI 302.1R-04: Guide for Concrete Floor and Slab Construction.
 - 3. ACI 302.2R-06: Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
 - 4. ACI 304.2R-96: Placing Concrete by Pumping Methods.
 - 5. ACI 305R-10: Hot Weather Concreting.
 - 6. ACI 306R-10: Cold Weather Concreting.
 - 7. ACI 308.1-11: Standard Specification for Curing Concrete.
 - 8. ACI 318 -05 Building Code Requirements for Structural Concrete.
 - 9. ASTM C 94/C 94M – 11b: Standard Specification for Ready- Mixed Concrete.
 - 10. ASTM C 494/C 494M - 11: Standard Specification for Chemical Admixtures for Concrete.
 - 11. ASTM F 710- 11: Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.

1.03 DEFINITIONS

- A. ACI 301, Section 1.2 - Definitions:
 - 1. a. Cementitious Material: Cementitious materials include cement, ground blast furnace slag and fly ash.
 - b. Corrosion Inhibitor Admixture: A liquid admixture, calcium nitrite that inhibits corrosion of concrete-embedded steel in the presence of chloride ions.
 - c. Pumped Concrete: Concrete that is conveyed by pumping pressure through rigid pipe or flexible hose.
 - d. Water-to-Cementitious Ratio (w/c): An ratio representing quantity in pounds of free moisture available for cement hydration divided by quantity of cementitious materials in pounds per cubic yard concrete.

1.04 SUBMITTALS

- A. Submittals Package: Submit product data for design mix(es) and materials for concrete specified below at the same time as a package.
- B. Product Data:
 - 1. Mix Design: Submit proposed concrete design mix(es) together with name and location of batching plant at least 28 days prior to the start of concrete work.
 - a. Include test results of proposed concrete proportions based on previous field experience or laboratory trial batches in accordance with ACI 301, Section 4.
 - b. Pumped Concrete: Include test results of proposed design mix(es) tested under actual field conditions with the maximum horizontal run and vertical lift required for this project.
 - 2. Portland Cement: Brand and manufacturer's name.
 - 3. Fly Ash: Name and location of source, and DOT test numbers.
 - 4. Air-entraining Admixture: Brand and manufacturer's name.
 - 5. Water-reducing Admixture: Brand and manufacturer's name.
 - 6. High Range Water-reducing Admixture (Superplasticizer): Brand and manufacturer's name.
 - 7. Corrosion Inhibitor Admixture: Brand and manufacturer's name.
 - 8. Accelerating Admixture: Brand and manufacturer's name.
 - 9. Aggregates: Name and location of source, and DOT test numbers.
 - 10. Lightweight Coarse Aggregates: Brand and manufacturer's name.
 - 11. Chemical Hardener (Dustproofing): Brand and manufacturer's name, and application instructions.
 - 12. Chemical Curing and Anti-Spalling Compound: Brand and manufacturer's name, and application instructions.
 - 13. Bonding Agent (Adhesive): Brand and manufacturer's name, and preparation and application instructions.
 - 14. Expansion Joint Fillers: Brand and manufacturer's name.
 - 15. Waterstop: Brand and manufacturer's name, and installation instructions.
 - 16. Emery Aggregate: Brand and manufacturer's name, and application instructions.
 - 17. Integral Water-Repellent Admixture: Brand, manufacturer name, specifications, and application instructions.
- C. Quality Control Submittals:
 - 1. Batching Plant Records: At the end of each day of placing concrete, furnish the Director's Representative with a legible copy of all batch records for the concrete placed.
 - 2. Concrete Pumping Equipment Data: Include manufacturer's name and model of principal components, type of pump, and type and diameter of pipe/hose.
 - 3. Minutes of the previous pre-installation conference.
- D. LEED Design Submittals:

1. MR Credit 4.1 and MR Credit 4.2: Identify manufacturer's name, the percentage of post-consumer recycled content by weight, the pre-consumer recycled content by weight, and the cost of the product.
2. MR Credit 5.1 and MR Credit 5.2: Identify source, cost, and the fraction by weight that is considered regional.

1.05 QUALITY ASSURANCE

- A. Qualifications of Crew Pumping Concrete: Workers pumping concrete shall have had at least one year of experience pumping concrete.
- B. Concrete batching plants shall be currently approved as concrete suppliers by the New York State Department of Transportation.
- C. Truck mixers for concrete shall be currently approved by the New York State Department of Transportation.
- D. Pumping equipment for pumped concrete shall be subject to the approval of the Director.
- E. Fly ash supplier shall be on the New York State Department of Transportation's current "Approved List of Suppliers of Fly Ash".
- F. Source Quality Control: The Director reserves the right to inspect and approve the following items, at his own discretion, either with his own forces or with a designated inspection agency:
 1. Batching and mixing facilities and equipment.
 2. Sources of materials.
- G. ACI 301, Section 1.3 Reference standards and cited publications:
 1. C 311-11a Standard Methods of Sampling and Testing Fly Ash or Natural Pozzolans For Use As A Mineral Admixture in Portland Cement Concrete.
- H. Pre-Construction Conference: A minimum of 14 days prior to the initial submission of shop drawings, a conference will be held by the Director's Representative at the Site for the purpose of reviewing the Contract Documents, and discussing the requirements and procedures for submittals and for the Work. The conference shall be attended by the Contractor, the concrete supplier representative, and the reinforcement fabricator's project coordinator.
 1. If resilient flooring is to be placed on slab-on-grade, the meeting will also include discussion of curing procedures and moisture mitigation measures.

1.06 DELIVERY

- A. ASTM C 94/C 94M, Article 14 - Batch Ticket Information: In addition to the information required by Paragraph 14.1, also include the following:
 1. Type and brand, and amount of cement.
 2. Weights of fine and coarse aggregates.
 3. Class and brand, and amount of fly ash (if any).

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement: ASTM C 150, Type I or II Portland cement.
- B. Water: Potable
- C. Air-entraining Admixture: ASTM C 260, and on the New York State Department of Transportation's current "Approved List".
- D. Water-reducing Admixture: ASTM C 494/C 494M, Type A, and on the New York State Department of Transportation's current "Approved List".
- E. High Range Water-reducing Admixture (Superplasticizer): ASTM C 494/C 494M, Type F, and on the New York State Department of Transportation's current "Approved List".
- F. Corrosion-Inhibiting Admixture: ASTM C 494/C 494M, for use in resisting corrosion of steel reinforcement.
 - 1. DCI Corrosion Inhibitor by W. R. Grace & Co., - Conn., 62 Whittemore Ave., Cambridge, MA 02140, (617) 876-1400 and Rheocrete CNI by Master Builders/ BASF Building Systems, 23700 Chagrin Blvd., Cleveland, OH 44122, (800) 628-9990.
 - 2. DCI - S Corrosion Inhibitor by W. R. Grace & Co., - Conn., 62 Whittemore Ave., Cambridge, MA 02140, (617) 876-1400.
- G. Retarding Admixture: ASTM C 494, Type D, Water-reducing and retarding, for use in hot weather concreting, and on the New York State Department of Transportation's current "Approved List".
- H. Accelerating Admixture: Non-corrosive admixture, containing no chloride, complying with ASTM C 494, Type C or E, and on the New York State Department of Transportation's current "Approved List".
- I. Fly Ash: ASTM C 618, including Table 1 (except for footnote A), Class F except that loss on ignition shall not exceed 4.0 percent.
- J. ACI 301, Section 4.2.1.2 - Aggregates:
 - 1. Fine aggregate for pumped concrete shall meet the requirements of ASTM C 33, except 15 to 30 percent shall pass the No. 50 sieve and 5 to 10 percent shall pass the No. 100 sieve. The fineness modulus of the fine aggregate for pumped concrete shall not vary more than 0.20 from the average value used in proportioning.
 - 2. Aggregates for lightweight concrete shall meet the requirements of ASTM C 330, except that fine aggregate for lightweight concrete shall meet the requirements of ASTM C 33.

3. Aggregates shall be taken from storage silos or other approved locations that have been tested and approved by the New York State Department of Transportation, unless otherwise approved in writing by the Director.
- K. Moisture-Retaining Cover: Waterproof paper, polyethylene film, or polyethylene-coated burlap complying with ASTM C 171.
- L. Chemical Curing and Anti-Spalling Compound: ASTM C-309, Type 1D, Class B, with a minimum 18 percent total solids content. No thinning of material allowed.
1. SureCure Emulsion, Kaufman Products, Inc. 3811 Curtis Avenue, Baltimore, MD 21226, (800) 637-6372.
 2. Cure & Seal by Symons Corp., 200 East Touhy Ave., PO Box 5018, Des Plaines, IL 60017-5018, (847) 298-3200.
 3. Kure-N-Seal by Sonneborn/ BASF Building Systems, 889 Valley Park Dr., Shakopee, MN 55379, (800) 433-9517.
 4. Day-Chem Cure & Seal UV 26 percent (J-22 UV) by Dayton Superior Corp., 721 Richard St., Miamisburg, OH 45342, (800) 745-3700.
 5. Acrylseal HS by Master Builders/ BASF Building Systems, 23700 Chagrin Blvd., Cleveland, OH 44122, (800) 628-9990.
- M. Chemical Hardener (Dustproofing): Colorless aqueous solution of magnesium-zinc fluosilicate.
1. Lapidolith by Sonneborn/ BASF Building Systems, 889 Valley Park Dr., Shakopee, MN 55379, (800) 433-9517.
 2. Surfhard by The Euclid Chemical Co., 19218 Redwood Rd., Cleveland, OH 44110, (216) 531-9222.
 3. Pena-Lith by W.R. Meadows, Inc., PO Box 543, Elgin, IL 60121, (847) 683-4500.
 4. FluoHard by L & M Construction Chemicals, Inc., 14851 Calhoun Rd., Omaha, NE 68152, (402) 453-6600.
 5. Armortop by Anti Hydro International, Inc., 265 Badger Ave., Newark, NJ 07108, (800) 777-1773.
 6. Diamond by Kaufman Products, Inc., 3811 Curtis Avenue, Baltimore, MD 21226, (800) 637-6372.
- N. Type 1 Expansion Joint Filler: Preformed, resilient, nonextruding cork units complying with ASTM D 1752, Type II.
- O. Type 2 Expansion Joint Filler: Preformed, resilient, nonextruding, self-expanding cork units complying with ASTM D 1752, Type III.
- P. Type 3 Expansion Joint Filler: Preformed, resilient, nonextruding bituminous units complying with ASTM D 1751.
- Q. Epoxy Bonding Agent (Adhesive): 100 percent solids epoxy-resin-base bonding compound, complying with ASTM C 881, Types I, II, IV and V, Grade 2 (horizontal areas) or Grade 3 (overhead/vertical areas), and Class B (40-60 degrees Fahrenheit) or Class C (60 degree Fahrenheit and above).
1. SurePoxy HM Series by Kaufman Products, Inc., 3811 Curtis Avenue, Baltimore, MD 21226, (800) 637-6372.

2. Sikadur Hi-Mod 32 by Sika Corporation, 201 Polito Avenue, Lyndhurst, NJ 07071, (800) 933-7452.
 3. Epogrip by Sonneborn/-BASF Building Systems, 889 Valley Park Drive, Shakopee, MN 55379, (800) 433-9517.
- R. Emery Aggregate: Natural emery, crushed, polyhedral in shape, with not more than 10 percent flat or elongated pieces, properly screened, graded and packaged in the manufacturer's plant, and delivered to the Site in sealed, labeled packages.
1. Emerundum by Anti Hydro International, Inc., 265 Badger Ave., Newark, NJ 07108, (800) 777-1773.
 2. Non-Slip Aggregate by Setcon Industries, Inc., 5 Mathews Ave., Riverdale, NJ 07457-1020, (201) 283-0500.
 3. Frictex H by Sonneborn/ BASF Building Systems, 889 Valley Park Dr., Shakopee, MN 55379, (800) 433-9517.
- S. Waterstop: Extruded from virgin polyvinyl chloride plastic compound containing no scrap or reclaimed material or pigment.
1. Size: Minimum 6 inches wide by 3/8 inch thick, unless otherwise indicated.
 2. Minimum Tensile Strength (ASTM D 412): 2000 psi.
 3. Minimum Ultimate Elongation (ASTM D 412): 350 percent.
 4. Shore A/10 Durometer Hardness (ASTM D 2240): Minimum 65; Maximum 83.
 5. Maximum 24 Hour Water Absorption (ASTM D 570): 0.15.
- T. Waterstop: Water swelling sealant; minimum 3/4 inch wide by 3/8 inch thick, unless otherwise indicated; minimum tensile strength (ASTM D 412) 100 psi minimum ultimate elongation (ASTM D 412) 500 percent.
1. MC-2010M by Adeka Ultra Seal Corporation, PO Box 459, Spearfish, SD 57783, (605) 642-3959.
 2. Volclay Waterstop RX-101 by Colloid Environmental Technologies Company, Building Materials Division, 1350 W. Shure Drive, Arlington Heights, IL 60004, (708) 392-5800.
- U. Expansion Joint Dowels: Smooth steel expansion joint dowel with minimum 5 inch long steel dowel cap, unless otherwise indicated.
- V. Integral Water-Repellent Admixture:
1. Hydrocide Powder by Sonneborn/ BASF Building Systems, 889 Valley Park Drive, Shakopee, MN 55379, (800) 433-9517.
 2. Darapel by W. R. Grace & Co., - Conn., 62 Whittemore Ave., Cambridge, MA 02140, (617) 876-1400.

2.02 PROPORTIONING OF MIXES

- A. Cast-in-place concrete shall be air-entrained normal weight concrete except where lightweight concrete is indicated on the drawings.
1. Normal weight concrete, except as otherwise specified, shall have a minimum compressive strength of 3000 psi with a minimum of 564 pounds per cubic yard or 4000 psi, with a minimum of 611 pounds of cement per cubic yard. Slump: Maximum 4 inches; minimum 2 inches

- before the addition of any water-reducing admixtures or high-range water-reducing admixtures (superplasticizers) at the Site.
2. Normal weight concrete for garage floors, and for exterior slabs, ramps and stairs shall have a minimum compressive strength of 4000 psi, with a minimum of 611 pounds of cement per cubic yard. Slump: Maximum 3 inches; minimum 2 inches before the addition of any water-reducing admixtures or high-range water-reducing admixtures (superplasticizers) at the Site.
 3. Optional Material: Fly ash may be substituted for (Portland) cement in normal weight and lightweight concrete up to a maximum of 15 percent by weight of the required minimum (Portland) cement. If fly ash is incorporated in a concrete design mix, make necessary adjustments to the design mix to compensate for the use of fly ash as a partial replacement for (Portland) cement.
 - a. Adjustments shall include the required increase in air-entraining admixture to provide the specified air content.
 - b. Lower early strength of the concrete shall be considered in deciding when to remove formwork.
- B. N/A
- C. Slump for Pumped Concrete: When a water-reducing admixture is not used, maximum slump shall be 4 inches. When a water-reducing admixture is used, maximum slump shall be 6 inches and when a high-range water-reducing admixture (superplasticizers) is used, maximum slump shall be 8 inches.
- D. Design Air Content: Design air content for concrete shall be 4 percent by volume, with an allowable tolerance of plus or minus 1.5 percent for total air content, except as otherwise specified. Use air-entraining admixture, not air-entrained cement.
- E. Water-Cement Ratio: Cast-in-place concrete shall have a maximum water-cement ratio of 0.40.
- F. ACI 301, Section 4.2.2.3: Change article to read as follows:
1. 4.2.2.3.a Normal Weight Concrete: Coarse aggregates shall conform to gradation requirements for various sizes as tabulated in Table No. 2 of ASTM C 33. The sizes of coarse aggregates for various classes of Work shall be as follows with all percentages being determined by weight.
 2. 4.2.2.3.b For concrete floors, floor and roof slabs, reinforced beams and girders, columns and piles, concrete encasing underground electric conduits, and concrete in which the space between restricting objects is 2 inches or less, the coarse aggregate shall be Size No. 67.
 3. 4.2.2.3.c For other concrete Work having a minimum cross-sectional dimension of not more than 6 inches, the coarse aggregate shall be a well graded mixture of No. 67 and No. 57, provided that not more than 50 percent nor less than 30 percent shall be Size No. 67 and not more than 70 percent nor less than 50 percent shall be Size No. 57.

4. 4.2.2.3.d For other concrete Work having a minimum cross-sectional dimension greater than 6 inches and not more than 12 inches, the coarse aggregate shall consist of a mixture of No. 67, No. 57 and No. 467, providing that not more than 25 percent nor less than 10 percent shall be Size No. 67 and not more than 40 percent shall be Size No. 467.
 5. 4.2.2.3.e For other concrete Work having a minimum cross-sectional dimension of more than 12 inches, the coarse aggregate shall consist of a mixture of No. 67, No. 57 and No. 357, providing not more than 25 percent nor less than 10 percent shall be Size No. 67 and not more than 40 percent shall be Size No. 357.
- G. Application Rate for Corrosion-Inhibiting Admixture shall be as manufacturer recommendation.
- H. Admixtures: Do not use admixtures in concrete unless specified or approved in writing by the Director.
- I. ACI 301, Section 4.1.2.1 - Mixture Proportions:
1. Proposed design mix(es) for pumped concrete and the pumping equipment shall have been tested under actual field conditions with the maximum horizontal run and vertical lift required for this project.
- J. Application Rate for Integral Water Repellent Admixture:
1. Hydrocide Powder, 1 lb. for each 94 lb. of cement
 2. Darapel, 3 to 6 oz. for each 100 lb. of cement.

2.03 JOINTS

- A. ACI 301, Section 5.3.2.6 - Construction joints and other bonded joints:
1.
 - a. The use of bonding agent (adhesive).
 - b. The use of cement grout.
- B. ACI 301, Section 10.2.5 – Isolation-joint filler materials:
1.
 - A. Except as otherwise shown on the Drawings, expansion joints shall be as follows:
 - In joints required to receive a sealant, the joint filler shall be 1/2 inch thick and recessed as required to form a caulking slot.
 - In joints not required to receive a sealant, the joint filler shall be 1/2 inch thick and extend through the full cross-section of the concrete.
 - Tool edges of concrete with 1/8 inch radius edging tool.

2.04 PRODUCTION OF CONCRETE

- A. Provide ready-mixed concrete, either central-mixed or truck-mixed, unless otherwise approved in writing by the Director.
- B. N/A
- C. ACI 301, Section 5.3.2.1 Weather considerations
 - 1. Provide adequate controls to insure that the temperature of the concrete when placed does not exceed 90 degrees F., and make every effort to place it at a lower temperature. The temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set or cold joints. Ingredients may be cooled before mixing by shading the aggregates, fog spraying the coarse aggregate, chilling the mixing water or other approved means. Mixing water may be chilled with flake ice or well-crushed ice of a size that will melt completely during mixing, providing the water equivalent of the ice is calculated into the total amount of mixing water.
- E. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placement and curing.
 - 1. In cold weather, comply with ACI 306R.
 - a. When air temperature is below 40 degrees F (4 degrees C) heat the mixing water and, if necessary, the aggregates to obtain a concrete mixture temperature of not less than 50 degrees F (10 degrees C) and not more than 80 degrees F (27 degrees C) at point of placement. If the mixing water is heated, do not exceed a temperature of 140 degrees F at the time it is added to the cement and aggregates.
 - 2. In hot weather, comply with ACI 305R.
 - a. When air temperature is between 85 degrees F (30 degrees C) and 90 degrees F (32 degrees C), reduce mixing and delivery time from 1 1/2 hours to 75 minutes, and when air temperature is above 90 degrees F (32 degrees C), reduce mixing and delivery time to 60 minutes.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Do not use items of aluminum for mixing, chuting, conveying, forming or finishing concrete, except magnesium alloy tools may be used for finishing.
- B. Check items of aluminum required to be embedded in the concrete and insure that they are coated, painted or otherwise isolated in an approved manner.
- C. Install waterstops in accordance with manufacturer's printed instructions.
- D. Hardened concrete, reinforcement, forms, and earth which will be in contact with fresh concrete shall be free from frost at the time of concrete placement.

- E. Do not deposit concrete in water. Keep excavations free of water by pumping or by other approved methods.
- F. Prior to placement of concrete, remove all hardened concrete spillage and foreign materials from the space to be occupied by the concrete.
- G. Prior to placement of a concrete slab-on-grade, insure roof is watertight and install polyethylene or other preventative measures to mitigate exposure to external moisture sources such as rainwater; runoff from adjacent slopes; landscaping water; water from curing; or wet grinding, sawing, and cleaning.
- H. Place vapor barrier directly under concrete slab-on-grade with no cushion or blotter layer.

3.02 ADMIXTURE ADDITIONS AT THE SITE

- A. Site additions shall be limited to high-range water-reducers, non-chloride accelerators, and corrosion inhibitors. Comply with manufacturers' printed instructions for discharge of admixtures shall be furnished.
- B. High-Range Water-Reducers:
 - 1. Concrete shall arrive at a slump of 2 to 4 inches (50 to 100 mm). Water additions at the Site shall be limited to comply with water-to-cementitious ratio requirements.
 - 2. Following addition of high-range water-reduced concrete, a minimum of 70 revolutions or 5 minutes of mixing shall be completed to assure a consistent mixture.
- C. All concrete with other admixture additions shall mix a minimum of 70 revolutions or 5 minutes to assure a consistent mixture.

3.03 PLACING

- A. ACI 301, Section 5.3.2.3 Conveying equipment:
 - 1. 5.3.2.3.d When pumping concrete, the lubricating mortar for the delivery line shall not be discharged into an area of concrete placement.
 - 2. 5.3.2.3.e The inside diameter of the delivery lines for pumped concrete shall be the greater of either a minimum of 5 inches or 3 times the maximum size of coarse aggregate.
- B. ACI 301, Section 5.3.2.2 - Conveying:
 - 1. Operation of truck mixers and agitators and discharge limitations shall conform to the requirements of ASTM C 94.
- C. ACI 301, Section 5.3.2.4 - Depositing:
 - 1. Do not allow concrete to free fall more than 4 feet.

3.04 REPAIRING SURFACE DEFECTS

- A. ACI 301, Section 5.3.7 – Repair of surface defects:
 - 1. Finish patched areas to match the texture of the surrounding surface.
- B. ACI 301, Section 5.3.7.2 - Repair of tie holes:
 - 1. The patch mixture shall consist of a mixture of dry-pack mortar, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for placing and handling. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

3.05 FINISHING FORMED SURFACES

- A. Finish Schedule: Except where indicated otherwise on the Drawings, provide the finishes below:
 - 1. Rough Form Finish for concrete surfaces not exposed to view.
 - 2. Smooth Form Finish for concrete surfaces exposed to view.
 - 3. Smooth Rubbed Finish for exterior concrete surfaces exposed to view.
 - 4. Grout Cleaned Finish for interior concrete surfaces exposed to view.
- B. ACI 301, Section 5.3.3.3 - As-cast Finishes:
 - 1. Fins shall be completely removed on surfaces to receive waterproofing.

3.06 SLABS

- A. Slabs On Grade: Provide key type joints unless otherwise shown. Tool exposed joints.
- B. ACI 301, Section 5.3.4 – Finishing unformed surfaces:
 - 1. Provide monolithic finishes on concrete floors and slabs without the addition of mortar or other filler material. Finish surfaces in true planes, true to line, with particular care taken during screeding to maintain an excess of concrete in front of the screed so as to prevent low spots. Screed and darby concrete to true planes while plastic and before free water rises to the surface. Do not perform finishing operations during the time free water (bleeding) is on the surface.
- C. Finish Schedule: Except where indicated otherwise on the Drawings, provide the finishes below:
 - 1. Floated Finish for:
 - a. Treads and platforms of exterior steps and stairs.
 - b. Slabs and fill over which waterproofing, roofing, vapor barrier, insulation, terrazzo, or resin bound flooring is required.
 - 2. Troweled Finish for:
 - a. Interior slabs that are to be exposed to view.
 - b. Slabs and fill over which resilient wood flooring, resilient tile or sheet flooring, carpet, or thin-film coating system is required.

- c. Slabs and fill over which thin-set ceramic tile is required, except fine-broom finished surface.
 - d. Treads and platforms of interior steps and stairs.
 - 3. Broom or Belt Finish for:
 - a. Exterior slabs. Texture as approved by the Director's Representative.
 - 4. Scratched Finish for:
 - a. Surfaces to be covered with ceramic tile set in a bonded thick mortar bed, except screed to a Class B tolerance.
 - b. Surfaces to be covered with floor topping.
 - 5. Integral Emery Aggregate Surfacing with Floated Finish for:
 - a. Interior pedestrian ramps.
- D. ACI 302 Chapter 8.2.8.2 - Tools for jointing; Saw-cutting.
 - 1. Early-entry dry-cut saws are preferred in place of conventional wet-cut saws.
- E. ACI 302 Chapter 8.3.12
 - 1. Begin saw-cutting as soon as the saw will not dislodge the aggregate or ravel the edge of the saw-cut, but in no case longer than 12 hours after the slab is placed. Saw-cut a minimum of one quarter of the slab depth leaving a clean, sharp edge in the pattern shown on the Contract Documents. Provide sufficient personnel and equipment to complete saw-cutting operations within 18 hours after the slab is placed.
- F. Exposed surfaces with fibrous reinforcement: After curing of the concrete, remove any protruding fibers in a manner which will not harm the parent concrete.
- G. Floor flatness and levelness tolerances: For flatness and levelness tolerances of floor slabs refer to ACI 302 Chapter 8.15. Floor surface tolerances shall be 1/8 inch over a horizontal distance of 10 feet in any direction, unless otherwise specified by floor profile quality classifications in ACI 302..
 - 1. When flatness or levelness tolerances are not met then the floor shall be ground or scarified and repoured to meet specifications.

3.07 CURING AND PROTECTION

- A. Hot Weather Concreting: Comply with ACI 305R whenever the atmospheric temperature or the form surface temperature is at or above 90 degrees F., or climatic conditions of wind and/or low humidity will cause premature drying of the concrete.
- B. Curing Temperature: Maintain the temperature of the concrete at 50 degrees F. or above during the curing period. Keep the concrete temperature as uniform as possible and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceeds 5 degrees F. in any one hour and 50 degrees F. in any 24-hour period.
- C. Curing and Moisture Mitigation for Resilient Flooring:

1. Acceptable curing and drying conditions include a minimum ambient temperature of 70 degrees F and a maximum relative humidity of 50%.
 - a. Air movement at 15 mph.
2. Do not cure slabs by adding water; ponding or wet burlap method.
3. Do not use curing compounds or cure-and-seal materials unless such use is approved in writing by the adhesive and floor covering manufacturers. The curing product manufacturer's conformance to ASTM c 1315 is not a substitute for the adhesive and floor covering manufacturer's approval.
4. Cure the slab by covering with waterproof paper, plastic sheets, or a combination of the two for 3 to 7 days.

3.08 CHEMICAL HARDENER (DUSTPROOFING)

- A. Apply chemical hardener to all troweled finished interior floors which are to be left exposed.
- B. Do not apply chemical hardener until concrete has cured the number of days recommended in manufacturer's instructions.
- C. Prepare surfaces and apply chemical hardener in accordance with manufacturer's printed instructions and recommendations.

3.09 FIELD QUALITY CONTROL

- A. ACI 301, Section 1.6.4.2 - Testing Services:
 - 1.6.4.2. j Strength Tests for Pumped Concrete: Prepare strength test specimens and make strength tests from concrete samples obtained at the truck discharge chute and at the end of the pump delivery line in accordance with paragraph 16.3.4.4.
- B. ACI 301, Section 1.6.3.3 – Tests required of Contractor's testing agency:
 1. Make available to the Director's Representatives whatever test samples are required to make tests. Furnish shipping boxes for compression test cylinders.
- C. Adjustment to Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to the State and as accepted by the Director. Laboratory test data for revised mix design and strength results must be submitted to and accepted by the Director's Representative before using in the work.
- D. Test results will be reported in writing to the Director's Representative, Ready-Mix Producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

- E. Nondestructive Testing: Impact hammer, Windsor probe, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- F. Additional Tests: The State shall make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by the Director's Representative. The testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Pay for such tests when unacceptable concrete is verified, including all inspection and Engineering fees when non-conforming work is verified.
- G. Moisture Testing: Test all slabs-on-grade for moisture content that will receive resilient flooring. For a preferred moisture testing method and limits; consult the written instructions of the floor covering manufacturer, the adhesive manufacturer, the patching/underlayment manufacturer, or combination thereof. Test repeatedly until the desired moisture content is obtained.
- H. pH Testing: Test concrete floors for pH level prior to the installation of resilient flooring. Do not exceed the recommended pH level of the resilient flooring manufacturer or the adhesive manufacturer, or both.

END OF SECTION

SECTION 040513

MORTAR AND MASONRY GROUT (As Applicable)

PART 1 GENERAL

1.01 REFERENCES

- A. Standards:
 - 1. Mortar: ASTM C 270, except as otherwise specified.
 - 2. Grout: ASTM C 476.

1.02 SUBMITTALS

- A. Product Data:
 - 1. Portland Cement: Brand and manufacturer's name.
 - 2. Masonry Cement: Brand and manufacturer's name.
 - 3. Lime: Brand and manufacturer's name.
 - 4. Sand(s): Location of pit, name of owner, and previous test data.
 - 5. Color Pigments: Brand and manufacturer's name.
- B. LEED Submittals: Submit the following as a separate submittal package, including information on each product specified:
 - 1. Local/Regional Materials:
 - a. Sourcing location(s): Indicate location of extraction, harvesting, and recovery of raw materials used in the products manufacturing; indicate distance between extraction, harvesting, and recovery and the project site.
 - b. Manufacturing location(s): Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - 2. Recycled content: Manufacturers certification of recycled content indicating percentage by weight of both pre-consumer and post-consumer recycled content.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials in a manner which will insure the preservation of their quality and fitness for the Work.
- B. Store cement and lime on raised platforms under waterproof, well ventilated cover.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement: One of the following complying with the indicated requirements:

1. Portland Cement: ASTM C 150, Type 1, of natural color or white as required to produce the desired color.
 - a. Fly Ash: Comply with ASTM C593.
 - 1) Recycled Content: Minimum 15 percent pre-consumer recycled content at contractor's option.
 - a) Type 1: 81 g, 15 percent.
 2. Masonry Cement: ASTM C 91, of natural color or custom color as required to produce the desired color.
 - a. Fly Ash: Comply with ASTM C593.
 - 1.) Recycled Content: Minimum 5 percent post-consumer recycled content, or minimum 20 percent pre-consumer recycled content at contractor's option.
 - a) Type M: 27 g, 5 percent; 108 g 20 percent.
 - b) Type S: 26 g, 5 percent; 102 g, 20 percent.
 - c) Type N: 24 g, 5 percent; 96 g 20 percent.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Mortar Sand: ASTM C 144, except that for joints less than 1/4 inch thick use sand graded with 100 percent passing the No. 16 sieve.
 1. Sand for White Mortar: Natural white sand or ground white stone.
 2. Sand for Colored Mortar: Ground marble, granite, or other sound stone, as required to match approved sample.
- D. Grout Sand: ASTM C 404.
- E. Color Pigments: High purity, finely ground, chemically inert, unfading, lime proof mineral oxides specially prepared for use in mortar.
- F. Water: Clean and free of deleterious amounts of acids, alkalis, and organic materials.

2.02 MIXES

- A. Mortar for Unit Masonry: Comply with ASTM C 270, proportion specifications, except limit materials to those specified.
 1. Colored Mortar: Proportion color pigments with other ingredients as necessary to match required color, except limit pigments other than carbon black to a maximum of 10 percent of cement content by weight and limit carbon black to a maximum of 3 percent of cement content by weight.
- B. Grout: Comply with ASTM C 476. If grout types are not indicated on Drawings, furnish type (fine or coarse) most suitable for the particular job conditions to completely fill cavities and embed reinforcement and other built-in items.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Refer to sections of Specifications which require mortar and masonry grout.

3.02 MORTAR SCHEDULE

- A. Where mortar types are not indicated on Drawings or specified, use types as follows:
1. Type M for unit masonry below grade in contact with fill materials.
 2. Type S for concrete masonry units.
 3. Type N for brick masonry units.
 - a. Proportion Portland cement, lime, and sand in a 1:1:6 ratio.

END OF SECTION

SECTION 042000

UNIT MASONRY (As Applicable)

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Mortar and masonry grout: Section 040513.

1.02 SUBMITTALS

- A. Shop Drawings: Submit shop drawings for precast concrete lintels.
- B. Product Data:
1. Mortar:
 - a. Portland Cement: Brand and manufacturer's name.
 - b. Masonry Cement: Brand and manufacturer's name.
 - c. Lime: Brand and manufacturer's name.
 - d. Sand: Location of pit, name of owner, and previous test data.
 - e. Color Pigments: Brand and manufacturer's name.
 2. Masonry Wall Reinforcement: Catalog sheets and specifications.
- C. Samples:
1. Brick: 1, each type, showing full range of color/shading and texture.
 2. Existing Brick to be Matched: 1, each type, for comparison to above.
 3. Concrete Masonry Units: 1, each size.
 4. Masonry Wall Reinforcement: 24 inch long sections.
- D. Quality Control Submittals:
1. Test Reports:
 - a. Brick: At the written request of the Director, submit certified test reports for each type of brick showing compressive strength, 24 hour cold water absorption, 5 hour boiling water absorption, saturation coefficient, and initial rate of absorption (suction).
 - b. Concrete Masonry Units: Submit certified test reports for each size showing that units for delivery to the Project meet the requirements of these Specifications.

1.03 PROJECT CONDITIONS

- A. Environmental Requirements:
1. Protect masonry and materials against freezing at temperatures below 40 degrees F.
 2. Do not use frozen materials or materials coated with ice or frost.
 3. Do not lower freezing point of mortar by use of antifreeze agents or other admixtures. Do not use calcium chloride in mortar.

PART 2 PRODUCTS (AS APPLICABLE)

2.01 FACING BRICK

- A. Facing Brick (Exterior): ASTM C 216, Grade SW, Type FBS.
 - 1. Size, Color, and Texture: Matching existing adjacent brickwork.
- B. Facing Brick (Interior): ASTM C 216, Grade MW, Type FBS.
 - 1. Size, Color, and Texture: Matching existing adjacent brickwork.
- C. Option: Facing brick may be either cored or solid except that only solid brick shall be used for corbeling and where cores would be exposed to view. If cored brick are furnished, core holes shall be not less than 3/4 inch from any edge and no more than 25 percent of the gross area of the brick.
- D. Special Molded Shapes: Furnish for applications where units cannot be sawn from standard sizes.

2.02 BUILDING (COMMON) BRICK

- A. Building Brick (Exterior): ASTM C 62, Grade SW.
 - 1. Size, Color, and Appearance: Matching existing adjacent brickwork.
- B. Building Brick (Interior and Back-Up): ASTM C 62, Grade MW.
 - 1. Size, Color, and Appearance: Matching existing adjacent brickwork.

2.03 CONCRETE MASONRY UNITS

- A. Hollow Load-Bearing Units: ASTM C 90, Type I.
- B. Solid Load-Bearing Units: ASTM C 90, Type I.
- C. Hollow Non-Load-Bearing Units: ASTM C 129, Type I.
- D. Concrete Building Brick: ASTM C 55, Type I, Grade N.
- E. Fire Rated Units: Aggregate type and equivalent solid thickness as required to obtain the fire resistance rating indicated. Fire resistance ratings shall be based on fire tests in accordance with ASTM E 119.
- F. Aggregate:
 - 1. Lightweight Units: ASTM C 331; dry net weight not more than 105 lb per cu ft.
 - 2. Normal Weight Units: ASTM C 33; dry net weight not less than 125 lb per cu ft.
- G. Special Shapes: Units of shape and size required for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions indicated.
 - 1. Outside Corners: Square edge units.
 - 1. Outside Corners: Bullnose units.
 - 2. Units for Walls and Partitions to be Filled with Loose Type Insulation: Two cell (core) units.

2.04 PRECAST CONCRETE LINTELS

- A. Lintels In Interior Walls Carrying Wall Loads Only: Lightweight concrete, 3000 psi minimum compressive strength at 28 days.
- B. Lintels Exposed On Exterior and Lintels Carrying Floor or Roof Loads: Normal weight concrete, 4000 psi minimum compressive strength at 28 days.
- C. Reinforcement:
 - 1. Bar Reinforcement: ASTM A 615, Grade 60, deformed steel bars.
 - 2. Fabric Reinforcement: ASTM A 185, welded wire fabric.
 - 3. Steel Wire: ASTM A 82, cold-drawn plain steel wire.
- D. Finishes:
 - 1. Surfaces Not Exposed To View: Smooth form finish.
 - 2. Interior Surfaces Exposed To View: Grout cleaned finish or match the finish of adjacent concrete masonry units.
 - 3. Exterior Surfaces Exposed To View: Smooth rubbed finish.
 - 4. Surfaces To Be Plastered: Roughened surface which will afford firm plaster bond.
- E. Length: As required for minimum bearing of 8 inches at each end, unless otherwise shown on the Drawings.

2.05 MORTAR AND MASONRY GROUT

- A. Mortar: ASTM C 270, proportion specifications. Types as follows:
 - 1. Type M for unit masonry below grade in contact with fill materials.
 - 2. Type S for concrete masonry units.
 - 3. Type N for brick masonry units.
 - a. Proportion Portland cement, lime, and sand in a 1:1:6 ratio.
- B. Color Pigments: High purity, finely ground, chemically inert, unfading, lime proof mineral oxides specially prepared for use in mortar.
 - 1. Proportion color pigments with other ingredients in mortar as necessary to match color of existing adjacent mortar joints.
- C. Grout: ASTM C 476, fine or coarse as most suitable for the particular job conditions.

2.06 ACCESSORIES

- A. Masonry Wall Reinforcement: Joint reinforcement factory fabricated from cold-drawn steel wire, truss or ladder design, 9 gage deformed steel wire longitudinal rods welded to 9 gage steel wire cross ties spaced 16 inches on center; width 1-1/2 to 2 inches less than wall thickness. Furnish factory-fabricated corner and tee sections for corners and wall intersections.
 - 1. Finish for Exterior Walls: 1.5 oz per sq ft hot dipped galvanized after fabrication.
 - 2. Finish for Interior Walls: 0.8 oz per sq ft mill galvanized.

3. Cavity Wall Construction: Ladder design fabricated with drip notch in cross ties centered over the cavity.
 4. For walls with concrete masonry unit back-up wythe, reinforcement shall have a third longitudinal rod located for proper embedment at internal face shell of concrete masonry units.
 5. Provide units with adjustable 2-piece rectangular ties where horizontal joints of facing wythe do not align with those of back-up.
- B. Bar Reinforcement: ASTM A 615, Grade 60, deformed steel bars.
1. Rebar Positioner: Fabricate from galvanized steel wire, 9 gage or 6.5 gage as required. Design to fit concrete masonry units, and number, size and location of rebars indicated. Products; Steel-Wich Telescoping Rebar Positioner™, P. O. Box 1936, Buffalo, NY 14240, (716) 683-7526; or No. 376, 377 by Heckmann Accessories, 4015 West Carroll Avenue, Chicago, IL 60624, (800) 621-4140.
- C. Buck Anchors (For Anchoring New Masonry To Existing Construction): 1-1/4 x 1/8 x 8 inch long Z type steel buck anchor with 2 inch long right angle bent ends, bolt hole in one bent end, 1.5 oz per sq ft hot dipped galvanized after fabrication. Furnish 3/8 inch diameter galvanized machine bolt and nonferrous metal expansion shield.
- D. Continuous Steel Angle (For Anchoring New Masonry to Existing Masonry): Continuous galvanized steel angles of sizes indicated with holes spaced 18 inches on center. Furnish galvanized steel anchors of sizes and types indicated or required.
- E. Masonry Veneer Anchors: Corrugated wall ties, 22 gage steel, 7/8 inch wide, 7 inches long, 1.5 oz per sq ft hot dipped galvanized after fabrication.
- F. Flexible Anchors: 1.5 oz per sq ft hot dipped galvanized steel anchors which will permit horizontal and vertical movement of masonry but will maintain lateral restraint, and as follows:
1. For Anchorage To Concrete Framework: 2 piece anchors with 12 gage sheet steel dovetail section and rectangular or vee-shaped 3/16 inch diameter wire tie section sized to extend to within one inch of face of masonry.
 2. For Anchorage To Steel Framework: 2 piece anchors with crimped 1/4 inch diameter bar for welding to steel and rectangular or vee-shaped 3/16 inch diameter wire tie section sized to extend to within one inch of face of masonry.
- G. Dovetail Anchor Slot Concrete Inserts: 24 gage galvanized steel, with filler strip; slot sized to fit dovetail anchor.
- H. Unit-Type Concrete Inserts: Cast iron or malleable iron, or fabricated 12 gage steel with 1.5 oz per sq ft hot-dip zinc coating.
- I. Masonry Wall Ties: 3/16 inch diameter cold-drawn steel wire, with 1.5 oz per sq ft hot-dip zinc coating after fabrication; Z-shaped for solid unit masonry,

rectangular shape for hollow unit masonry; 2 piece adjustable type where wythe courses are not aligned.

- J. Tiebars: 1-1/4 x 1/4 x 28 inch long steel bars with 3 inch long right angle bent ends, 1.5 oz per sq ft hot dipped galvanized after fabrication. Adjust length of bars as required when obstructions are encountered.
- K. Metal Lath: Galvanized, expanded metal lath weighing not less than 3.4 pounds per square yard.
- L. Hardware Cloth: 16 gage, 1/2 inch square mesh, galvanized steel wire mesh.
- M. Premolded Control Joint Strips: Solid rubber strips of profile indicated (to maintain lateral stability of wall); 60-80 Shore A durometer hardness.
- N. Asphalt Felt (For Mortar Control Joints): No. 15 asphalt saturated organic felt; ASTM D 226.
- O. Clay Flue Lining: ASTM C 315.
- P. Masonry Flashing: Copper fabric consisting of 7 oz copper sheet with asphalt impregnated glass fabric bonded to both sides.
 - 1. Joint Sealant: Trowel grade asphalt roofing cement.

2.07 SOURCE QUALITY CONTROL

- A. Tests:
 - 1. Test brick in accordance with ASTM C 67.
 - 2. Test concrete masonry units in accordance with ASTM C 140 and ASTM C 426.
 - 3. Have tests performed by a qualified independent testing laboratory.

PART 3 EXECUTION (AS APPLICABLE)

3.01 PREPARATION

- A. Lay out walls and partitions with one course of unit masonry, or other suitable means, to define the spaces, locations of doors and other openings, and to serve as a guide for other trades in the installation of conduits, pipes, etc.
- B. Allow other trades sufficient opportunity to install built-in work before proceeding with the walls and partitions. Do not cover pipes, conduit, or ductwork in masonry until directed by the Director's Representative.
- C. Wet brick that absorb 20 drops of water (placed in a one inch circle) in less than 90 seconds.
- D. Clean off supporting surface under first course of masonry just prior to laying the masonry units.

- E. Protection:
 - 1. Protect face materials against staining.
 - 2. Protect newly laid masonry from exposure to precipitation, excessive drying, freezing, soiling, backfill, and other harmful elements.
 - 3. Cover top of walls with non-staining waterproof covering when Work is not in progress. Place with minimum 2 foot overhang of protective covering on each side of wall and securely anchor.

3.02 INSTALLATION

- A. Install masonry units plumb and true to line with level courses accurately spaced.
 - 1. Install masonry units in running bond unless otherwise indicated.
 - 2. Install masonry units in existing masonry bond pattern. Match existing unit masonry coursing and joints.
 - 3. Take special care when laying masonry units to be left exposed, or upon which high-build glazed coating, paint, or thin set tile will be applied. Surface plane tolerance for such Work: 1/8 inch in 10 feet in all directions.
- B. Adjust units to final position while mortar is soft and plastic. Remove units disturbed after mortar has stiffened; clean units and joints of mortar and re-lay in fresh mortar.
- C. Lay only dry concrete masonry units.
- D. Where cutting of masonry units is necessary, cut with a power saw. Lay out Work to avoid use of less than half-size units.
- E. Lay hollow units with full mortar coverage on horizontal and vertical face shell surfaces. Bed webs in mortar in starting course on footings and foundation walls, in all courses of piers, columns and pilasters, where adjacent to cells or cavities to be reinforced or filled with concrete or mortar, and within 1'-6" of each side of openings.
- F. Lay solid units with full mortar coverage on horizontal and vertical joint surfaces.
- G. Collar Joints: Except in cavity walls, fill vertical-longitudinal joint between wythes by slushing and rodding the joint full of mortar.
- H. Cavity Wall Construction: Keep cavities clean of mortar droppings.

3.03 JOINTS

- A. Construct uniform mortar joints, 3/8 inch thick unless otherwise indicated.
- B. Strike joints flush in surfaces to be plastered, stuccoed, or covered with other masonry or other surface applied finish other than smear and high-build glazed coating.

- C. Cut joints flush and tool slightly concave on both sides of other walls and partitions, including inner wythe of exterior cavity walls.

3.04 HORIZONTAL JOINT REINFORCEMENT

- A. Reinforce horizontal joints with continuous masonry wall reinforcement spaced every 16 inches vertically except as follows:
 - 1. Space 8 inches vertically in parapet walls.
 - 2. Also reinforce horizontal joints immediately above and below openings for a distance of 2'-0" beyond opening in both directions.
- B. Do not bridge control joints or expansion joints with reinforcement.
- C. Lap ends of adjoining strips of reinforcement 6 inches or more.
- D. Install factory fabricated corner and tee sections at corners and wall intersections respectively.

3.05 TYING ADJACENT WYTHES

- A. Tie adjacent wythes of masonry walls together with continuous masonry wall reinforcement spaced vertically not more than 16 inches on center. Install reinforcement as specified under HORIZONTAL JOINT REINFORCEMENT.
- A. Tie adjacent wythes of masonry walls together with masonry wall ties spaced 16 inches vertically and 24 inches horizontally.

3.06 BONDING WITH MASONRY

- A. Lay masonry units in masonry bond for the following:
 - 1. External corners of partitions and walls.
 - 2. Pilasters, piers, and columns.
 - 3. Intersections of walls and partitions with a door opening within one foot of intersection. Fill cells between the intersection and the door frame with mortar to the full height of the door.

3.07 TYING INTERSECTING WALLS AND PARTITIONS

- A. Except where masonry bond is specified, terminate abutting walls and partitions flush against the face of the abutted walls. Tie intersections at every second course as follows:
 - 1. Load-Bearing Walls: Install tiebars. Embed bent ends in cells filled with mortar. Install pieces of metal lath under the cells to support the mortar fillings.
 - 2. Non-Load-Bearing Walls: Install ties of masonry wall reinforcement tee sections or strips of hardware cloth embedded in mortar.
 - a. Center standard length masonry wall reinforcement tee sections on the walls.
 - b. Width of hardware cloth strips shall be the width of the abutting wall less 1-1/2 inches; length shall be 24 inches or twice the

width of the abutted wall, whichever is greater. Center the strips on the abutting wall and extend across intersection to 3/4 inch from the farthest face of the abutted wall.

- B. Fill vertical joint at intersection of abutted walls and partitions solid with mortar. If a control joint is located at the intersection, rake out both sides of joint to a depth of 3/8 inch.

3.08 ANCHORING

- A. Anchor walls adjoining or intersecting structural framing, and dependent upon structural framing for lateral support, to structural members with flexible anchors secured to structural members.
 - 1. Space flexible anchors 16 inches on center, unless otherwise shown on the Drawings.
- B. Anchoring Partitions and Infill Abutting Existing Construction: Install buck anchors in bed joints 16 inches on center vertically. Embed one bent end in cell filled with mortar and expansion bolt other bent end to existing construction.
- C. Anchoring Partitions and Infill Abutting Existing Construction: Install continuous steel angle anchored to existing construction 18 inches on center. Break portion of web in new concrete masonry unit to fit into steel angle. Prevent bond to angle. Fill core of concrete masonry unit at angle with grout.
- D. Anchoring Masonry Veneer: Install one anchor for each 4 sq ft of wall area. Space anchors not more than 24 inches horizontally and vertically. Embed anchors at least 2 inches in horizontal joint of facing. Install additional anchors around openings; place anchors within 12 inches of opening, spaced at not more than 24 inch centers around perimeter.

3.09 CONTROL AND EXPANSION JOINTS

- A. Install control and expansion joints at locations indicated. Keep joints free of mortar and debris.

3.10 WEEP HOLES

- A. Form weep holes in exterior wythe of cavity walls by leaving head joint free and clean of mortar, and raking out bed joint at weep hole. Form weep holes approximately 24 inches on center along bottom of cavity over foundations, bond beams, through wall flashings, and other water-stops in the wall. Keep weep holes free of mortar droppings.

3.11 BUILT-IN WORK

- A. Avoid cutting and patching.
- B. Build-in bolts, anchors, nailing blocks, inserts, frames, vents, flashings, conduit and other items as masonry work progresses.

- C. Fit masonry units closely around built-in items. Fill voids around built-in items with mortar for anchorage. Solidly fill space between masonry and metal frames with mortar.
- D. Unless otherwise shown on the Drawings, construct 1/4 inch to 3/8 inch wide open joint around outside perimeter of exterior door and window frames and other framed exterior wall openings to receive sealant. Rake joints and tool smooth to a uniform depth of 1/4 inch.
- E. Flashings: Clean contact surfaces and remove projections which might puncture the flashing. Place flashing on bed of mortar and cover with mortar. Seal joints with joint sealant.

3.12 LINTELS

- A. Install lintels over openings in masonry. Center lintel over opening. Set in full bed of mortar under each end.

3.13 CLEANING

- A. Cut off mortar projections remaining from tooling joints and dry-brush masonry before the end of each day's work.
- B. Additional Cleaning for Brickwork:
 - 1. Clean with stiff brushes and water.
 - 2. If staining or soiling persists, reclean with stiff brushes and a solution of trisodium phosphate, detergent, and water (1/2 cup of trisodium phosphate and 1/2 cup of detergent to each gallon of water). Rinse with clean water.
 - 3. If the above methods are unsuccessful, as judged by the Director's Representative, reclean with an approved (determined by a sample area test) liquid masonry cleaning agent in accordance with the manufacturer's instructions.

3.14 SCHEDULE FOR CONCRETE MASONRY UNITS

- A. Unless shown otherwise on the Drawings, use the various kinds of concrete masonry units specified at the locations indicated below:
 - 1. Hollow Load-Bearing Units (Normal Weight):
 - a. Use for exposed exterior Work.
 - b. Use for Work in which the same masonry units are exposed on both the interior and exterior.
 - 2. Hollow Load-Bearing Units (Lightweight):
 - a. Use for interior bearing walls, pilasters, piers, and columns, and for interior wythe of exterior bearing walls.
 - 3. Solid Load-Bearing Units (Lightweight):
 - a. Use for stair enclosures, pipe shafts, ventilator shafts, elevator shafts, and dumbwaiter shafts.
 - b. Use for walls supporting wall-hung plumbing fixtures.

- c. Use for enclosing refrigerator spaces. Fill cells completely with mortar or provide 100 percent solid units.
- 4. Hollow Non-Load-Bearing Units (Lightweight):
 - a. Use for interior Work including wall backing, except as otherwise specified above.

END OF SECTION

SECTION 055000

METAL FABRICATION BROAD SCOPE

PART 1 GENERAL (AS APPLICABLE)

1.01 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Anchor Bolts.
- B. Loose Bearing Plates: Installed under Section 042000.
- C. Loose Lintels: Installed under Section 042000.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Field Painting: Section 099103.

1.03 REFERENCES

- A. Except as shown or specified otherwise, the Work of this Section shall meet the requirements of the following:
 - 1. Design, Fabrication, and Erection: "Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design" adopted by the American Institute of Steel Construction, June 1, 1989 (AISC Specification).
 - a. Design and Fabrication of Cold-Formed Shapes: "Specification for the Design of Cold-Formed Steel Structural Members", by the American Iron and Steel Institute (AISI Specification).
 - 2. Welding: "Structural Welding Code - Steel, AWS D1.1", or "Structural Welding Code - Sheet Steel, AWS D1.3", by the American Welding Society (AWS Codes).
- B. Organizations:
 - 1. AISC: American Institute of Steel Construction, One East Wacker Dr., Suite 700, Chicago, IL 60601-1802, 866-275-2472, www.aisc.org.
 - 2. AISI: American Iron and Steel Institute, 1140 Connecticut Ave., NW, Suite 705, Washington, D.C. 20036, (202) 452-7100, www.steel.org.
 - 3. AWS: American Welding Society, 550 N.W. LeJeune Rd., Miami, FL 33126, (800) 443-9353, www.aws.org.
 - 4. ANSI: American National Standards Institute, 1819 L Street, NW, 6th Floor, Washington, DC 20036, (202) 293-8020, www.ansi.org.
 - 5. ASME: ASME International, 3 Park Ave., New York, NY 10016-5990, (800) 843-2763, www.asme.org.
 - 6. ASTM: ASTM International, 100 Barr Harbor Dr., PO Box C700, West Conshohocken, PA, 19428-2959, (610) 832-9500, www.astm.org.
 - 7. MPI: The Master Painters Institute Inc., 2808 Ingleton Ave., Burnaby, BC, V5C 6G7, (888) 674-8937, www.specifypaint.com.
 - 8. SSPC: The Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburgh PA 15222-4656, (877) 281-7772, www.sspc.org.

1.04 SUBMITTALS

- A. Shop Drawings: Show application to project. Machine duplicated copies of Contract Drawings will not be accepted.
 - 1. Locate anchor bolts required for installation in other Work; furnish setting drawings and templates for required anchors.
 - 2. Indicate shop and field welds by standard AWS welding symbols in accordance with AWS A2.4.
 - 3. Floor Grating: Submit erection plan; include cutout areas and clearances.
- B. Product Data: Catalog sheets, specifications, and installation instructions for each fabricated item specified, except submit data for fasteners only when indicated.
- C. LEED Design Submittals:
 - 1. MR Credit 4.1 and MR Credit 4.2: Identify manufacturer's name, the percentage of post-consumer recycled content by weight, the pre-consumer recycled content by weight, and the cost of the product.
 - 2. MR Credit 5.1 and MR Credit 5.2: Identify source, cost, and the fraction by weight that is considered regional.

1.05 QUALITY ASSURANCE

- A. Galvanizing: Stamp galvanized items with galvanizer's name, weight of coating, and applicable ASTM number.

1.06 DELIVERY AND STORAGE

- A. Coordinate delivery of anchor bolts and other anchorage devices to be built into other construction to avoid delay.
- B. Promptly cover and protect steel items delivered to the site.

PART 2 PRODUCTS (AS APPLICABLE)

2.01 MATERIALS

- A. Steel Shapes, Plates, and Bars: ASTM A 36.
- B. Steel Plates to be Bent or Cold-Formed: ASTM A 283, Grade C.
- C. Steel Bars and Bar-Size Shapes: ASTM A 675, Grade 70; or ASTM A 36.
- D. Merchant Quality Steel Bars: ASTM A 575, grade as selected by fabricator.
- E. Cold-Finished Steel Bars: ASTM A 108, grade as selected by fabricator.
- F. Hot-Rolled Carbon Steel Sheet and Strip: ASTM A 569, pickled and oiled.

- G. Cold-Rolled Carbon Steel Sheet: ASTM A 366, oiled.
- H. Galvanized Steel Sheet: ASTM A 526, with G90 hot-dip process zinc coating complying with ASTM A 525.
- I. Steel Tubing: ASTM A 501, hot-formed, welded or seamless, structural tubing.
- J. Cold-Drawn Steel Tubing: ASTM A 512, buttwelded, cold-finished carbon steel tubing, sink drawn and stress relieved.
- K. Cast Iron Castings: ASTM A 48, gray iron castings, Class 30.
- L. Malleable Iron Castings: ASTM A 47, grade as selected by fabricator.
- M. Steel Castings: ASTM A 27, grade and class as required by use of item.
- N. Steel Pipe: ASTM A 53, type as selected, Grade A; black finish unless galvanizing is required; standard weight (Schedule 40), unless otherwise shown or specified.
- O. Rolled Steel Floor Plate, Raised Pattern: ASTM A 786; raised herringbone pattern unless otherwise indicated.
- P. Stainless Steel: Type 302/304; ASTM A 666 for plate, sheet and strip; ASTM A 276 for bars and shapes; ASTM A 269 for tubing.
- Q. Anchors: Except where shown or specified, select anchors of type, size, style, grade, and class required for secure installation of metal fabrications. For exterior use and where built into exterior walls, anchors shall be galvanized or of corrosive-resistant materials.
 - 1. Threaded-Type Concrete Inserts: Galvanized ferrous casting, internally threaded to receive 3/4 inch diameter machine bolt; either malleable iron or cast steel.
 - 2. Wedge-Type Concrete Inserts: Galvanized box-type ferrous casting, designed to accept 3/4 inch diameter bolt having special wedge-shaped head; either malleable iron or cast steel.
 - a. Bolts: Carbon steel bolts having special wedge-shaped heads, nuts, washers and shims.
 - 3. Slotted-Type Concrete Inserts: Galvanized 1/8 inch thick pressed steel plate complying with ASTM A 283; box-type welded construction with slot designed to receive 3/4 inch diameter square head bolt and with knockout cover.
 - 4. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent test agency.
 - a. Carbon Steel: Zinc-Plated; ASTM B 633, Class Fe/Zn 5.

- b. Stainless Steel: Bolts, Alloy Group 1 or 2; ASTM F593, Nuts; ASTM F 594.
- R. Fasteners: Except where shown or specified, select fasteners of type, size, style, grade, and class required for secure installation of metal fabrications. For exterior use and where built into exterior walls, fasteners shall be galvanized.
 - 1. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
 - 2. Stainless Steel Fasteners: ASTM A 666; Type 302/304 for interior Work; Type 316 for exterior Work; Phillips flathead (countersunk) screws and bolts for exposed Work unless otherwise specified.
 - 3. Eyebolts: ASTM A 489.
 - 4. Machine Bolts: ASME B18.5 or ASME B18.9, Type, Class, and Form as required.
 - 5. Machine Screws: ASME B18.6.3.
 - 6. Lag Screws: ASME B18.2.1.
 - 7. Wood Screws: Flat head, ASME B18.6.1.
 - 8. Plain Washers: Round, ASME B18.22.1.
 - 9. Lock Washers: Helical, spring type, ASME B18.21.1.
 - 10. Toggle Bolts: Spring Wing Type; Wing AISI 1010, Trunion Nut AISI1010 or Zamac Alloy, Bolt Carbon Steel ANSI B18.6.3.
- S. Shop Paint (General): 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.
- T. Shop Paint for Galvanized Steel: Epoxy zinc-rich primer; complying with MPI#20 and compatible with topcoat.
- U. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- V. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.02 MISCELLANEOUS FRAMING AND SUPPORTS

- A. Fabricate metal framing and supports, which are not a part of the structural steel framework, to support related items required by the Work.
- B. Fabricate units to the sizes, shapes, and profiles indicated or, if not indicated, of required dimensions to receive adjacent Work to be retained by the framing. Except as otherwise indicated, fabricate from structural steel shapes, plates, and bars, of all welded construction, with mitered corners, necessary brackets and splice plates, and a minimum number of joints for field connection. Punch, drill, and tap units to receive hardware and similar items to be anchored to the Work.
- C. When required to be built into masonry or cast-in-place concrete, equip units with integrally welded anchor straps. Unless otherwise indicated, anchors shall be minimum 1-1/4 x 1/4 x 8 inch steel straps, spaced 2 feet oc.

- D. Galvanize exterior steel framing and supports.

2.03 MISCELLANEOUS STEEL TRIM

- A. Fabricate trim of shapes, sizes, and profiles shown. Fabricate units from steel shapes, plates, and bars, with continuously welded joints and smooth exposed edges, unless otherwise indicated. Use concealed field splices wherever possible. Furnish cutouts, fittings, and anchorages as required for assembly and installation.
- B. Galvanize exterior steel trim.

2.04 FIXED LADDERS

- A. Fabricate ladders to span between elevations at locations indicated. Comply with the requirements of ANSI A 14.3 unless otherwise shown or specified.
- B. Side Rails: Continuous, structural steel, flat solid bars with eased edges, spaced 18 inches apart.
 - 1. Rail Size: 1/2 x 2-1/2 inches.
 - 2. Rail Size: 3/8 x 2-1/2 inches.
- C. Rungs: Structural steel, round solid bars, spaced 12 inches oc.
 - 1. Rung Size: 1 inch diameter.
 - 2. Rung Size: 3/4 inch diameter.
 - 3. Non-slip Surface: The top of each rung shall have a non-slip surface, achieved either by coating the rung with aluminum oxide grit set in epoxy resin adhesive or by use of manufactured rung filled with aluminum oxide grout.
- D. Fit rungs into punched holes in centerline of side rails, plug weld and grind welds smooth on outer face of rails.
- E. Supports: Locate supports for each side rail near top rung, at bottom of ladder, and at intermediate points spaced not more than 5'-0" oc. Use welded or bolted steel brackets or straps for wall anchors, designed for adequate support and anchorage to hold the ladder 6 inches clear of the wall surface and other obstructing construction.
- F. Except for ladders terminating at a hatch, extend side rails 3'-6" minimum above top rung and return rails to wall or structure; if construction does not extend above the top rung, goose-neck the extended rails back to the structure. Flare out side rails for through ladder extensions. For side-step ladders, continue the rungs also in the extension.
- G. Galvanize exterior ladders and supports.
- H. Safety Chain: ASTM A 666; Type 316 stainless steel, straight link individually welded, 3/8 inch trade size.

1. Eye Bolts: Drop forged stainless steel, shoulder pattern, threaded, 1/4 inch diameter.
2. Snap Eye Bolts: Chrome plated, 5/8 inch swivel loop, 3/8 inch snap opening.

2.05 LOOSE BEARING PLATES

- A. Steel plates fabricated flat, free from warp or twist, and of required thickness and bearing area. Drill plates as required for anchor bolts and for grouting access. Furnish bearing plates where shown and where required for steel items bearing on masonry or concrete construction.

2.06 LOOSE LINTELS

- A. Structural steel shape lintels, fabricated for openings and recesses in masonry walls and partitions as indicated. Loose lintels bearing on masonry or concrete shall have a minimum end bearing length of 6 inches at each end, unless otherwise shown.
- B. Galvanize lintels to be installed in exterior walls.

2.07 SHELF ANGLES

- A. Galvanized structural steel shelf angles of sizes shown, fabricated for attachment to concrete framing. Angles shall have slotted holes, to receive 3/4 inch bolts, spaced not more than 6 inches from ends and not more than 24 inches oc, unless otherwise shown.
 1. Furnish wedge-type concrete inserts and fasteners for attachment of shelf angles to cast-in-place concrete.

2.08 STRUCTURAL STEEL DOOR FRAMES

- A. Fabricate structural steel door frames of structural shapes and bars as indicated, fully welded, uniform, square, and true. Plug weld built-up members. Continuously weld exposed joints; grind exposed welds smooth. Unless otherwise indicated, fabricate stops of 5/8 x 1-3/4 inch steel bars, plug welded to frames except where removable stops are indicated. Secure removable stops to frame with countersunk machine screws uniformly spaced not more than 10 inches oc. Secure necessary reinforcements, and drill and tap as required for finish hardware.
- B. Wall Anchors: 1/8 x 2 inch steel strap anchors of length required for 8 inches minimum embedment into adjoining concrete or masonry. Weld an anchor to jambs of frame 12 inches maximum from both bottom and head of frame, and weld intermediate anchors spaced 16 inches oc maximum.
- C. Floor Anchors: Steel angle clip welded to back of frame at bottom of each jamb. Prepare clips for anchorage to floor construction indicated.
- D. Prepare frames to receive approved finish hardware. Form slots in frames for hardware strikes unless otherwise specified. Reinforce frames where indicated,

and attach 12 gage welded steel plate box closures on back of frames where slots for hardware occur.

- E. Galvanize exterior structural steel door frames and anchors.

2.09 STEEL PIPE RAILINGS AND HANDRAILS

- A. Fabricate railings and handrails of 1-1/2 inch (nominal) diameter steel pipe, unless otherwise shown.
- B. Railings: Unless otherwise shown, railings shall consist of top rail and intermediate rails, with posts spaced not more than 4 feet oc. Close ends of rails which do not terminate with a flange or continuous return.
1. Space rails so that a sphere 4 inches in diameter cannot pass through the openings between the rails.
 2. Join posts, rails, and corners by one of the following methods:
 - a. Flush-type steel railing fittings, welded and ground smooth, with railing splice locks secured with 3/8 inch hexagonal-recessed-head setscrews.
 - b. Coped and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding joints smooth. Butt railing splices and reinforce by a tight-fitting interior pipe sleeve not less than 6 inches long secured in place.
 3. Railings may be bent at corners instead of joining, provided the bends are uniformly formed in jigs, with cylindrical cross-section of pipe maintained throughout the entire bend.
 4. Unless otherwise shown, fabricate railings and accessories as necessary to secure posts and rail ends to construction as follows:
 - a. Anchor posts in concrete by means of post sleeves preset into the concrete.
 - b. Anchor posts to steel with steel flanges, angle type or floor type as required by conditions, welded to posts and bolted to the steel supporting members.
 - c. Anchor rail ends into concrete and solid masonry with round steel flanges welded to rail ends and anchored into the wall construction with expansion anchors.
 - d. Anchor rail ends to steel with oval or round steel flanges welded to rail ends and bolted or welded to the steel supporting members.
 5. Post Sleeves: Galvanized steel pipe not less than 6 inches long, and having an inside diameter not less than 1/2 inch greater than the outside diameter of the pipe post. Sleeve shall have a plate closure, sized to extend not less than 1 inch beyond the outside diameter of the sleeve, secured to the bottom of the sleeve.
 - a. Cover Flange: Round steel flange, sized to closely fit post and cover the sleeve.
 6. Fabricate removable railing sections as indicated on the Drawings.
 7. Kickplates: Flat steel bars 3/16 inch thick by not less than 6 inches high. Secure kickplates as shown.

- C. Handrails: Pipe handrails shall be secured to walls by means of wall brackets, and shall have a wall return fitting at each end of handrails unless otherwise shown.
 - 1. Wall Brackets: Malleable iron castings, with 3 inches projection from the finish wall surface to the center of the handrail, and with the wall plate portion of the bracket drilled to receive one 3/8 inch diameter bolt. Brackets shall be located approximately 6 inches from each end of handrails and intermediate brackets equally spaced at intervals not exceeding 5 feet oc. Fabricate wall brackets to secure to wall construction as follows:
 - a. Anchor into concrete and solid masonry with expansion anchors.
 - b. Anchor into hollow masonry and stud partitions with toggle bolts having square heads.
 - 2. Wall Return Fittings: Cast iron castings, flush-type, with the same projection as specified for wall brackets.
- D. Galvanize all exterior railings and handrails, and interior railings and handrails where indicated on the Drawings, including pipe, flanges, fittings, brackets, fasteners, and other ferrous metal components.

2.10 SAFETY NOSINGS

- A. Nosings: Cast, abrasive non-slip type, of profiles indicated, extending full length of concrete treads or other concrete edges to be protected unless otherwise indicated. Equip each nosing with integrally cast, welded, or riveted anchors located not more than 4 inches from each end of nosing and intermediate anchors spaced not over 15 inches oc. Abrasive grain shall be integrally cast into the wearing surface.
 - 1. Metal:
 - 2. Tread Nosing Units: 4 inches wide x 5/16 inch thick, with 1 inch minimum deep protective front lip.
 - 3. Curb Bar Nosing Units: 2-1/2 x 2-1/2 x 1/2 inch thick.
 - 4. Curb Bar Nosing Units: 1-1/2 x 1-1/2 x 3/8 inch thick.
 - 5. Surface Design: Cross-hatched abrasive.
 - 6. Surface Design: Fluted abrasive.
 - 7. Surface Design: Plain abrasive.

2.11 TRENCH COVERS

- A. Acceptable Products:
 - 1. R-4990 Series, heavy duty, Type L bolted trench frame with a Type A grated cover by Neenah Foundry Company, 2121 Brooks Ave., Neenah, WI 54956, (800) 558-5075, www.nfco.com.
 - 2. B-H20G Series, heavy duty, Type L bolted trench frame with Type A grates by Barry Pattern & Foundry Company's, 3333 35th Ave. North, Birmingham, AL 35207, (800) 524-1809, www.barrycraft.com.
- B. Frames: Heavy duty rated, gray cast iron castings with continuous rabbet to receive grating cover, and with integrally cast tie-anchor lugs and anchors spaced not more than 24 inches oc. Furnish frame end piece at each end of trench, and tie bolts for tie-anchor lugs.

1. Auxiliary Flat Bar Anchors: Steel bar anchors 3/16 inch thick x 1 inch wide x approximately 4 inches long, with 1-1/2 inch long bent end, and hole for tie bolt in other end. Furnish flat bar anchor at each pair of tie-anchor lugs and at the single tie-anchor lugs at trench ends, except at joints in concrete slab.
- C. Grated Covers: Heavy duty rated, gray cast iron castings fabricated into 2 feet long sections.
- D. Removable Dams: Steel plate, fabricated as shown, and galvanized.

2.12 FLOOR GRATING

- A. Grating: Rectangular, welded steel bar grating designed to support 200 lb/sq ft with deflection not exceeding 1/180. Fabricate with bearing bars on edge, and with all intersecting and abutting members joined by the electro-pressure welding method for the full depth of cross bar. Steel Bars: ASTM A 569.
 1. Top Surface of Bearing Bars: Plain.
 2. Top Surface of Bearing Bars: Serrated.
 3. Finish: One coat of grating manufacturer's standard shop paint.
 4. Finish: Galvanized.
 5. Fasteners for Removable Panels: Saddle clip anchor assembly, with self-drilling screw or weldable stud bolt. Clips shall have same finish as grating.
 6. Banding: Continuous steel bar of same material and size as bearing bars, welded to grating panel.
 7. Close Outs at Steps and Stairs: Special grating panel with nosing edge for platform ending at top of stairs.
 8. Toeplate: Flat steel bar curb secured to outer edge of grating where shown.

2.13 FABRICATION

- A. Use materials of the sizes and thicknesses indicated on the Drawings. If not indicated, use material of required size and thickness to produce adequate strength and durability for the intended use of the finished product.
- B. Fabricate items to be exposed to view of material entirely free of surface blemish, including pitting, roller and seam marks, rolled trade names, and roughness. Remove surface blemishes by grinding or by welding and grinding prior to cleaning, treating, and finishing.
- C. Form metal true to line, with accurate angles, surfaces, and straight edges. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise shown. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing the metal.
- D. Weld corners and seams continuously. Grind exposed welds smooth and flush, to match and blend with adjoining surfaces.

- E. Form exposed connections with flush, smooth, hairline joints. Use concealed fasteners wherever possible. Use Phillips flathead (countersunk) screws or bolts for exposed fasteners, unless otherwise shown or specified.
- F. Prepare fabricated items for anchorage of the type indicated, coordinated with the supporting structure. Fabricate and space anchoring devices as indicated or, if not indicated, as required to produce adequate support for the intended use of the item.
- G. Punch, reinforce, drill, and tap fabricated items as required to receive hardware and other appurtenant items.
- H. Galvanizing:
 - 1. In addition to specific items specified or noted to be galvanized, galvanize items attached to, embedded in, or supporting exterior masonry (including interior wythe of exterior masonry walls) and concrete Work.
 - 2. Unless otherwise specified or noted, items indicated to be galvanized shall receive a zinc coating by the hot-dip process, after fabrication, complying with the following:
 - a. ASTM A 123 for plain and fabricated material, and assembled products.
 - b. ASTM A 153 for iron and steel hardware.
- I. Shop Painting:
 - 1. Cleaning Steel: Thoroughly clean all steel surfaces. Remove oil, grease, and similar contaminants in accordance with SSPC SP-1 "Solvent Cleaning". Remove loose mill scale, loose rust, weld slag and spatter, and other detrimental material in accordance with SSPC SP-2 "Hand Tool Cleaning", SSPC SP-3 "Power Tool Cleaning", or SSPC SP-7 "Brush-Off Blast Cleaning".
 - 2. Galvanized Items:
 - a. Galvanized items which are to be finish painted under Section 099101 shall be rinsed in hot alkali or in an acid solution and then in clear water.
 - b. Welded and abraded areas of galvanized surfaces shall be wire brushed and repaired with a coating of cold galvanizing compound.
 - 3. Apply one coat of shop paint to all steel surfaces except as follows:
 - a. Do not shop paint steel surfaces to be field welded and steel to be encased in cast-in-place concrete.
 - b. Apply 2 coats of shop paint, before assembly, to steel surfaces inaccessible after assembly or erection, except surfaces in contact.
 - c. Do not paint galvanized items which are not to be finish painted under Section 099101.
 - 4. Apply paint and compound on dry surfaces in accordance with the manufacturer's printed instructions, and to the following minimum thickness per coat:
 - a. Shop Paint (General): 4.0 mils wet film.
 - b. Shop Paint for Galvanized Steel: 3.0 mils wet film.
 - c. Galvanizing Repair Paint: 2.0 mils dry film.

PART 3 EXECUTION

3.01 PREPARATION

- A. Temporarily brace and secure items which are to be built into concrete, masonry, or similar construction.
- B. Isolate non-ferrous metal surfaces to be permanently fastened in contact with ferrous metal surfaces, concrete, or masonry by coating non-ferrous metal surface with bituminous mastic, prior to installation.

3.02 INSTALLATION

- A. Fit and set fabricated metal items accurately in designed locations, at proper elevation and alignment.
- B. Use anchorage devices and fasteners of required type, size, and number as required to provide a secure, rigid installation.
- C. Fit exposed connections accurately to form tight hairline joints. Weld connections which are not intended to be left as exposed joints, but cannot be shop welded because of size limitations. Grind welded joints smooth. Cut off exposed threaded portion of bolts flush with nut.
- D. Attached Work: Drill holes for fasteners with power tools to exact size required. Unless otherwise shown on the Drawings, fasten metal Work to concrete and solid masonry anchorage with expansion anchors. Fasten metal Work to hollow masonry and stud partitions with square head toggle bolts.
- E. Field Welding: Comply with AWS Codes for the procedures for shielded metal arc welding, for the appearance and quality of welds, and for the methods used in correcting welding Work.
- F. Railings: Adjust railings prior to securing in place to insure alignment and proper matching at joints. Plumb posts in each direction. Secure posts and rail ends to construction as follows:
 - 1. Anchor posts in concrete with post sleeves preset into the concrete. After the posts have been inserted into the sleeves, fill the annular space between post and sleeve solid with molten lead or an exterior quick-setting hydraulic cement. Cover anchorage joint with a cover flange.
 - 2. Anchor posts to steel with steel flanges, angle type or floor type as required. Weld flanges to posts, and bolt to the steel supporting members.
 - 3. Anchor rail ends to concrete and masonry with round steel flanges. Weld flanges to rail ends, and anchor into the wall construction with expansion anchors.
 - 4. Anchor rail ends to steel with steel oval or round flanges. Weld flanges to rail ends, and weld or bolt to the steel supporting members.

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- G. Grating: Weld grating to supporting members, unless otherwise shown or specified.
 - 1. Secure removable panels with saddle clip anchor assemblies.

END OF SECTION

SECTION 078401

FIRESTOPPING MECHANICAL AND ELECTRICAL

PART 1 GENERAL

1.01 REFERENCES

- A. UL 1479 Fire Tests of Through-Penetration Firestops.
- B. ASTM E 814 Method of Fire Tests of Through-Penetration Fire Stops.

1.02 DEFINITIONS

- A. UL Fire Resistance Directory: Product directory published yearly, with supplements, by Underwriters Laboratories Inc., containing listings and classifications in effect as of the published date for product categories covered by UL.
- B. Inchcape Directory of Listed Products: Product directory published yearly by Inchcape Testing Services containing listings which reflect certifications granted for materials, products, systems and equipment which have been tested by Inchcape Testing Services to recognized governing standards.
- C. Omega Point Laboratories Listings Directory: Product Directory published yearly by Omega Point Laboratories, Inc. containing listed building products, materials, and assemblies which have been tested by Omega Point Laboratories to recognized governing standards.
- D. Factory Mutual Approval Guide: Product directory published yearly, with supplements, by Factory Mutual Research Corp., containing listed building products, materials, and assemblies which have been tested by Factory Mutual Research Corp., to recognized governing standards.
- E. F Rating: Prohibits flame passage through the system and requires acceptable hose stream test performance.
- F. T Rating: Prohibits flame passage through the system and requires the maximum temperature rise on the unexposed surface of the wall or floor assembly, on the penetrating item and on the fill material not to exceed 325 degrees F above ambient, and requires acceptable hose stream test performance.
- G. Company Field Advisor: An employee of the Company which lists and markets the primary components of the system under their name who is certified in writing by the Company to be technically qualified in design, installation, and servicing of the required products or an employee of an organization certified by the foregoing Company to be technically qualified in design, installation and servicing of the required products. Personnel involved solely in sales do not qualify.

1.03 DESIGN REQUIREMENTS

- A. Devices and materials shall meet the hourly fire resistance ratings required by the Project as determined by UL 1479, or ASTM E 814 and be listed and detailed in the UL Fire Resistance Directory, Inchcape Directory of Listed Products, Factory Mutual Approval Guide, or the Omega Point Laboratories Listings Directory.
 - 1. Exception: Where no listed designs exist that meet the requirements of a specific project condition, submit details and manufacturer's written recommendations for a design meeting the requirements. Include evidence of engineering judgement and extrapolation from listed designs.

1.04 SUBMITTALS

- A. Submittals Package: Submit the following items specified below the same time as a package:
 - 1. Product Data.
 - 2. Samples.
 - 3. Quality Control Submittals.
 - 4. Firestop Schedule.
- B. Product Data: Catalog sheets, specifications and installation instructions for each firestop device and material.
 - 1. Indicate design number for each firestop proposed to be used which is detailed in the UL Fire Resistance Directory, Inchcape Directory of Listed Products, Factory Mutual Approval Guide, or the Omega Point Laboratories Listings Directory.
 - 2. State the specific locations where each firestop system is proposed to be installed.
- C. Samples: One of each product if requested.
- D. Quality Control Submittals:
 - 1. Design Data: Show details and include engineering information and manufacturer's written recommendations required under Design Requirements Article for each proposed firestop if other than a design detailed in the UL Fire Resistance Directory, Inchcape Directory of Listed Products, Factory Mutual Approval Guide, or the Omega Point Laboratories Listings Directory.
 - a. State the specific locations where each firestop is proposed to be installed.
 - 2. Installer's Qualifications Data:
 - a. Name of each person who will be performing the Work and their employer's name, business address and telephone number.
 - b. Names and addresses of 3 similar projects that each person has worked on during the past 5 years.
 - 3. Company Field Advisor Data:
 - a. Name, business address and telephone number of Company Field Advisor secured for the required services.
 - b. Certified statement from the Company listing the qualifications of the Company Field Advisor, and listing of services and each product specifically listed for this Project for which Company

Field Advisor is given authorization by the Company to render advice.

- E. Firestop Schedule: Submit schedule itemizing the following:
1. Manufacturer's product reference numbers and/or drawing numbers.
 2. UL, Inchcape Testing Services, Factory Mutual Research Corp., or Omega Point Lab design number.
 3. Location of firestop material.
 4. Penetrating Item Description/Limits: Material, size, insulated or uninsulated, and combustibility.
 5. Maximum allowable annular space or maximum size opening.
 6. Wall type construction.
 7. Floor type construction.
 8. Hourly Fire resistance rating of wall or floor.
 9. F rating.
 10. T rating, if available.

NOTE: Firestop Schedule is for information only, and will not be acted on for approval. Refer to Sample Firestop Schedule bound in Appendix.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: The persons installing the firestopping and their supervisor shall be personally experienced in firestop work and shall have been regularly employed by a company installing firestopping for a minimum of 3 years.
- B. Pre-Installation Conference: Before the firestop work is scheduled to commence, a conference will be called by the Director's Representative at the Site for the purpose of reviewing the Contract Documents and discussing requirements for the Work. The conference shall be attended by related trade Contractors (if any), their qualified firestopping installers, and associated firestopping manufacturer's Company Field Advisors.
- C. Container/Package Labels: Include manufacturer's name and identifying product number, date of manufacturer, lot number, shelf life (if applicable), qualified testing and inspecting agency classification marking, curing time, and mixing instructions for multi-component materials.
- D. Company Field Advisor: Secure the services of a Company Field Advisor for the following:
1. Render advice regarding suitability of firestopping materials and methods.
 2. Assist in completing firestop schedule.
 3. Attend pre-installation conference.
- E. Field-Constructed Sample Installations: Prior to installing firestopping, erect sample installations for each type through-penetration firestop system indicated in the Firestop Schedule to verify selections made and to establish standard of quality and performance by which the firestopping work will be judged.

1. Build sample installations to comply with the following requirements, using materials indicated for final installations.
 - a. Locate sample installations on site at locations where directed.
 - b. Obtain Director's Representative's acceptance of sample installations before start of firestopping installation.
 - c. Retain and maintain sample installations during construction in an undisturbed condition.
 - d. Accepted sample installations in an undisturbed condition at time of substantial completion of Project may become part of completed firestopping work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver firestopping materials to the Site in original, new unopened containers or packages bearing manufacturer's printed labels.
- B. Store and handle firestopping materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, etc.

1.07 PROJECT CONDITIONS

- A. Environmental Requirements:
 1. Temperature: Do not install firestopping materials when ambient or substrate temperatures are outside limits permitted by manufacturer of firestopping materials.
 2. Humidity and Moisture: Do not install the Work of this Section under conditions that are detrimental to the application, curing, and performance of the materials.
 3. Ventilation: Provide sufficient ventilation wherever firestopping materials are installed in enclosed spaces. Follow manufacturer's recommendations.

1.08 SEQUENCING AND SCHEDULING

- A. Leave exposed those firestopping installations that are to be concealed behind other construction until the Director's Representative has examined each installation.

PART 2 PRODUCTS

2.01 FIRESTOPPING-GENERAL

- A. Through-Penetration Firestop Devices, Forming Materials, And Fill, Void or Cavity Materials: As listed in the UL Fire Resistance Directory, Inchcape Directory of Listed Products, Factory Mutual Approval Guide, or the Omega Point Laboratories Listings Directory.
 1. For firestopping exposed to moisture, furnish products that do not deteriorate when exposed to this condition.

2. For firestopping systems exposed to view, furnish products with flame-spread values of less than 25 and smoke developed values less than 50, as determined per ASTM E 84.
 3. For penetrations for piping services below ambient temperature, furnish moisture-resistant through-penetration firestop systems.
 4. For penetrations involving insulated piping, furnish through-penetration firestop systems not requiring removal of insulation.
- B. Accessories: Components required to install fill materials as recommended by the firestopping manufacturer for particular approved fire rated system.
- C. Identification Labels:
1. Furnished by fire stopping manufacturer of suitable material for permanent field identification of through-penetration firestops.
 2. Identify the following:
 - a. "WARNING - FIRESTOP MATERIAL".
 - b. Company Name.
 - c. Product Catalog number.
 - d. F rating.
 - e. T rating, if available.
 3. Field fabricated labels are not acceptable.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine existing through-penetrations of floors, walls, partitions, ceilings and roofs in the Work areas.
- B. Where firestopping is missing or not intact, submit a written report to the Director's Representative describing the existing conditions.

3.02 PREPARATION

- A. Clean out openings immediately before installation of through-penetration firestopping. Comply with recommendations of firestopping manufacturer and the following requirements:
 1. Remove foreign materials from surfaces of openings, and from penetrating items that could interfere with adhesion of firestopping.
 2. Clean opening and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
 3. Remove laitance and form release agents from concrete.
- B. Protection:
 1. Protect surfaces adjacent to through-penetration firestops with non-staining removable masking tape or other suitable covering to prevent firestopping from contacting adjoining surfaces that will remain exposed upon completion of Work and that would otherwise be permanently

stained or damaged by such contact or that would be caused by cleaning methods used to remove smears from firestopping materials.

- C. Substrate Priming:
 - 1. Prime substrates in accordance with the firestopping manufacturer's printed installation instructions using recommended products and methods.
 - 2. Do not allow primer to spill or migrate onto adjoining exposed surfaces.

3.03 INSTALLATION OF THROUGH PENETRATION FIRESTOPS

- A. Use through-penetration firestop devices, forming materials, and fill, void or cavity materials to form through-penetration firestops to prevent the passage of flame, and limit temperature rise of the unexposed surface as detailed in the UL Fire Resistance Directory, Inchcape Directory of Listed Products, Factory Mutual Approval Guide, or the Omega Point Laboratories Listings Directory.
 - 1. Where applicable design is not detailed in the Directories, use forming materials and fill, void or cavity material to form through-penetration firestop in accordance with approved printed details and installation instructions from the company producing the forming materials and fill, void or cavity material.
 - 2. If the construction type(s) of the building cannot be determined, provide firestopping with fire resistance ratings as specified in the Building Code of New York State, Tables 720.1(1), 720.1(2), 720.1(3), and 302.3.2.
- B. Provide through-penetration firestop systems with F ratings which shall equal or exceed the fire resistance rating of the penetrated building construction.
- C. Provide through-penetration firestop systems with T ratings, in addition to F ratings, at floors where the following conditions exist:
 - 1. Where firestop systems protect penetrations located outside the wall cavities.
 - 2. Where firestop systems protect penetrations located outside fire resistive shaft enclosures.
 - 3. Through-penetration firestop systems protecting floor penetrations require a T-rating of at least 1 hour, but not less than the required floor fire-resistance rating.
- D. Firestop through-penetrations of floors, walls, partitions, ceilings, and roofs.
- E. Firestop through-penetrations associated with the new Work.
- F. Firestop through-penetration of partitions identified on the Construction Work Drawings as smoke partitions and fire rated assemblies.
- G. Firestop through-penetrations of floors, walls, partitions, ceilings, and roofs in accordance with the fire resistance rating assigned to the walls, partitions, floors, ceilings, and roofs on the Construction Work Drawings.
- H. In areas where through-penetration items have been installed before the construction work, firestop the through-penetration items after the construction

work has been completed. Furnish drawings or written information to the Construction Work Contractor covering the provisions to be made in the construction work to enable firestopping of the through-penetration items.

- I. Permanently affix label at each firestop. Use adhesive compatible with surface construction at firestop location.

3.04 CLEANING

- A. Clean off excess fill materials and sealants adjacent to penetrations by methods and cleaning materials recommended by manufacturers of firestopping products and of products in which penetrations occur.
- B. Remove masking tape as soon as practical so as not to disturb the firestopping's bond with substrate.
- C. Protect firestopping during and after curing period from contact with contaminating substances, or damage resulting from adjacent Work.
- D. Cut out and remove damaged or deteriorated firestopping immediately, and install new materials as specified in firestop schedule.

END OF SECTION

SECTION 099103

MECHANICAL PAINTING

PART 1 GENERAL

1.01 DEFINITIONS

- A. The word “paint” in this Section refers to substrate cleaners, fillers, sealers, primers, undercoats, enamels and other first, intermediate, last or finish coatings.
- B. The word “primer” in this Section refers to substrate cleaners, fillers, sealers, undercoats, and other first or intermediate coats beneath the last or finish coating.
- C. The words “finish paint” in this Section refers to the last or final coat and previous coats of the same material or product directly beneath the last or final coat.
- D. Finish Paint Systems: Finish paint and primers applied over the same substrate shall be considered a paint system of products manufactured or recommended by the finish coat manufacturer.
 - 1. Finish paint products shall meet or exceed specified minimum physical properties.

1.02 SUBMITTALS

- A. Painting Schedule: Cross-referenced Painting Schedule listing all exterior and interior substrates to be painted and specified finish paint type designation; product name and manufacturer, recommended primers and product numbers, and finish paint color designation for each substrate to be painted.
 - 1. Designate exterior substrates by building name and number, substrate to be painted and surface location.
 - 2. Designate interior substrates by building name and number, floor, room name and number, and surface to be painted.
- B. Product Data Sheets: Manufacturer’s published product data sheets describing the following for each finish paint product to be applied:
 - 1. Percent solids by weight and volume, solvent, vehicle, weight per gallon, ASTM D 523 gloss/reflectance angle, recommended wet and dry film thickness, volatile organic compound (VOC) content in lbs/gallon, product use limitations and environmental restrictions, substrate surface preparation methods, directions and precautions for mixing and thinning, recommended application methods, square foot area coverage per gallon, storage instructions, and shelf-life expiration date.
 - 2. Manufacturer’s recommended primer for each finish paint product and substrate to be painted.
 - 3. Manufacturer’s complete range of available colors for each finish paint product to be applied.

- C. Finish Paint Type Samples: Two finish paint samples applied over recommended primers for each substrate to be painted.
 - 1. Samples shall be in the designated color and specified ASTM D 523 reflectance.
 - 2. Label each sample with the following information:
 - a. Project number and Painting Schedule designation describing substrates and locations represented by the sample.
 - b. Finish paint and primer manufacturer, product names and numbers, finish paint color and reflectance.
 - 3. Leave a 1 inch wide exposed strip of unpainted substrate and each coat of primer and finish paint.
 - 4. Sample Sizes:
 - a. Sheet Metals: 4 inch by 8 inch flat sheets.
 - b. Bar and Tubular Metals: 8 inch long bars or tubular stock.
- D. Quality Control Submittals:
 - 1. Test Reports: Furnish certified test results from an independent testing laboratory, showing that products submitted comply with the specifications, when requested by the Director's Representative
 - 2. Certificates: Furnish certificates of compliance required under QUALITY ASSURANCE Article.

1.03 QUALITY ASSURANCE

- A. Volatile Organic Compounds (VOCs) Regulatory Requirements: Chapter III of Title 6 of the official compilation of Codes, Rules and Regulations of the State of New York (Title 6 NYCRR), Part 205 Architectural Surface Coatings.
 - 1. Certificate of Compliance: List of each paint product to be delivered and installed. List shall include written certification stating that each paint product listed complies with the VOC regulatory requirements in effect at the time of job site delivery and installation.
- B. Container Labels: Label each product container with paint manufacturer's name, product name and number, color name and number, thinning and application instructions, date of manufacture, shelf-life expiration date, required surface preparations, recommended coverage per gallon, wet and dry film thickness, drying time, and clean up procedures.
- C. Field Examples:
 - 1. Prior to on-site painting, at locations designated by the Director's Representative, apply field examples of each paint type to be applied.
 - 2. Field examples to be applied on actual substrates to be painted and shall duplicate earlier approved paint samples.
 - a. Field Example Minimum Wet and Dry Film Thickness: As indicated on approved product data sheet.
 - b. Application: Apply each coat in a smooth uniform wet mil thickness without brush marks, laps, holidays, runs, stains, cloudiness, discolorations and other surface imperfections.
 - 1) Leave a specified exposed width of each previous coat beneath each subsequent coat of finish paint and primer.

- c. Use of Field Examples: Field examples shall serve as a quality control standard for acceptance or rejection of painting Work to be done under this Section.
 - 3. Field Example Sizes:
 - a. Mechanical Equipment: 20 square feet with 1 foot wide strips.
 - b. Linear Substrate Examples: 20 lineal feet with 12 inch long strips.
 - 4. Do not begin applying paints represented by field examples until examples have been reviewed and approved by the Director's Representative.
 - a. Protect and maintain approved field examples until all painting work represented by the example has been completed and approved.
- D. Compatibility of Paint Materials: Primers and intermediate paints shall be products manufactured or recommended by the finish paint manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to the Site in original, unopened containers and cartons bearing manufacturer's printed labels. Do not deliver products which have exceeded their shelf life, have been subjected to freezing temperatures, are in open or damaged containers or cartons, or are not properly labeled as specified.
- B. Storage and Handling: Store products in a dry, well ventilated area in accordance with manufacturer's published product data sheets. Storage location shall have an ambient air temperature between 55 degrees F and 85 degrees F.

1.05 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Ambient Air Temperature, Relative Humidity, Ventilation, and Surface Temperature: Comply with paint manufacturer's published product data sheet or other printed product instructions.
 - 2. If paint manufacturer does not provide environmental requirements, use the following:
 - a. Ambient Air Temperature: Between 60 degrees F and 80 degrees F.
 - b. Relative Humidity: Between 30-65 percent.
 - c. Ventilation: Maintain the painting environment free from fumes and odors throughout the Work of this Section.
 - d. Surface Temperature: At least 5 degrees F above the surface dewpoint temperature.
 - 3. Maintain environmental requirements throughout the drying period.
- B. The following items are not to be field painted unless otherwise specified, noted or directed:
 - 1. Stainless steel, chrome plated or monel surfaces.
 - 2. Ductwork to be insulated.
 - 3. Insulation on concealed piping and concealed ductwork.

4. Insulated items covered with aluminum, stainless steel, or PVC jacketing.
5. Uninsulated mechanical equipment with factory applied baked on enamel finish.
6. Mechanical equipment with enameled steel insulated jacket.
7. Prefabricated multi-wall chimneys.

1.06 EXTRA MATERIALS

- A. Provide extra finish paint materials, from the same production run as paints to be applied, in the following quantities for each color installed:
1. Paint Types EAL and IAL: Two gallons.
 2. Color Coded Paints: One gallon, each type.
 3. Other Paint Types: One gallon, each type.

PART 2 PRODUCTS

2.01 PAINT MANUFACTURERS

- A. Where noted, the following finish paint manufacturers produce the paint types specified.
1. Ameron Protective Coatings, 201 Berry St., Brea, CA 92621, (800) 926-3766.
 2. Armstrong World Industries, Inc., P.O. Box 3001, Lancaster, PA 17604, (800) 866-5639.
 3. Benjamin Moore and Co., 51 Chestnut Ridge Rd., Montvale, NJ 07645, (201) 573-9600.
 4. ICI Dulux Paints, 4000 DuPont Cr., Louisville, KY 40207, (800) 984-5444.
 5. Inorganic Coatings, Inc., 500 Lapp Rd., Malvern, PA 19355, (800) 345-0531.
 6. Insl-X, 50 Holt Drive, P.O. Box 694, Stony Point, NY 10980, (845) 786-5000.
 7. PPG Architectural Finishes, One PPG Plaza, Pittsburgh, PA 15272, (800) 441-9695.
 8. Rust-Oleum Corporation, 11 Hawthorn Pky., Vernon Hills, IL 60061, (800) 553-8444.
 9. Sherwin-Williams Co., Cleveland, OH 44101; 1-800-321-8194.
 10. Valspar Corp., 1401 Severn St., Baltimore, MD 21230, (800) 638-7756.
 11. Wm. Zinsser & Co., 39 Belmont Dr., Somerset, NJ 08875-1285, (908) 469-8100.

2.02 MISCELLANEOUS PRODUCTS

- A. Cleaning Solvents: Low toxicity with flash point in excess of 100 degrees F.
- B. Color Pigments: Pure, non-fading, finely ground pigments with at least 99 percent passing a 325 mesh sieve.
1. Use lime-proof color pigments on masonry, concrete and plaster.
 2. Use exterior pigments in exterior paints.

- C. Galvanizing Compound, Cold: Single component compound with 93 percent pure zinc in the dried film and meeting the requirements of DOD-P-21035A (NAVY).
- D. Masking Tape: Removable paper or fiber tape, self-adhesive and non-staining.
- E. Metal Filler: Polyester resin base autobody filler.
- F. Mineral Spirits: Low odor type recommended by finish paint manufacturer.
- G. Paint Stripper: As recommended by finish paint manufacturer.
- H. Stain Blocker, Primer-Sealer: As recommended by finish paint manufacturer.
- I. Turpentine: ASTM D 13.

2.03 FINISH PAINT TYPES

- A. Physical Properties:
 - 1. Specified percent solids by weight and volume, pigment by weight, wet and dry film thickness per coat, and weight per gallon are minimum physical properties of acceptable materials.
 - a. Opaque Pigmented Paints: Physical properties specified are for white titanium dioxide base before color pigments are added.
 - b. Specified minimum wet and dry film thickness per coat are for determining acceptable finish paint products. Minimum wet and dry film thickness per coat to be applied shall comply with approved finish paint manufacturer's product data sheets.
 - 2. Gloss or Reflectance: The following ASTM D 523 specified light levels and angles of reflectance:
 - a. Flat: Below 15 at 85 degrees.
 - b. Eggshell: Between 5 and 20 at 60 degrees.
 - c. Satin: Between 15 and 35 at 60 degrees.
 - d. Semigloss: Between 30 and 65 at 60 degrees.
 - e. Gloss: Over 65 at 60 degrees.
- B. Exterior Finish Paint Types:
 - 1. Paint Type EAL-1: Exterior Acrylic Latex, Flat.
 - a. Solids by Weight: 52.0 percent.
 - b. Solids by Volume: 32.0 percent.
 - c. Solvent: Water.
 - d. Vehicle: 100 percent acrylic resin.
 - e. Weight per Gallon: 10.5 lbs.
 - f. Wet Film Thickness: 4.0 mils.
 - g. Dry Film Thickness: 1.3 mils.
 - h. Manufacturers: ICI Dulux, PPG, Sherwin-Williams.
 - 2. Paint Type EAL-2: Exterior Acrylic Latex, Semigloss Enamel.
 - a. Solids by Weight: 47.0 percent.
 - b. Solids by Volume: 33.2 percent.
 - c. Solvent: Water.

- d. Vehicle: 100 percent acrylic resin.
 - e. Weight per Gallon: 10.0 lbs.
 - f. Wet Film Thickness: 4.0 mils.
 - g. Dry Film Thickness: 1.3 mils.
 - h. Manufacturers: ICI Dulux, PPG, Sherwin-Williams.
 - 3. Paint Type EAL-3: Exterior Acrylic Latex, Gloss Enamel.
 - a. Solids by Weight: 40.0 percent.
 - b. Solids by Volume: 32.0 percent.
 - c. Solvent: Water.
 - d. Vehicle: 100 percent acrylic resin.
 - e. Weight per Gallon: 10.0 lbs.
 - f. Wet Film Thickness: 3.4 mils.
 - g. Dry Film Thickness: 1.2 mils.
 - h. Manufacturers: Benjamin Moore, PPG, Sherwin- Williams.
 - 4. Paint Type ESP: Exterior Steel Zinc-Rich Primer, Flat.
 - a. Solids by Weight: 79.0 percent.
 - b. Solids by Volume: 68.0 percent.
 - c. Pigment by Weight: 90.0 percent zinc.
 - d. Solvent: Water.
 - e. Weight per Gallon: 24.6 lbs.
 - f. Dry Film Thickness: 3.0 mils if finish coated, 4.0 mils if not finish coated.
 - g. Manufacturers: Ameron Protective Coatings, Inorganic Coatings, Valspar.
- C. Interior Finish Paint Types:
- 1. Paint Type IAL-1: Interior Acrylic Latex, Flat.
 - a. Solids by Weight: 50.0 percent.
 - b. Solids by Volume: 32.0 percent.
 - c. Solvent: Water.
 - d. Vehicle: Vinyl acrylic resin.
 - e. Weight per Gallon: 10.9 lbs.
 - f. Wet Film Thickness: 3.8 mils.
 - g. Dry Film Thickness: 1.3 mils.
 - h. Manufacturers: Benjamin Moore, ICI Dulux, Sherwin-Williams.
 - 2. Paint Type IAL-2: Interior Acrylic Latex, Eggshell.
 - a. Solids by Weight: 51.0 percent.
 - b. Solids by Volume: 35.0 percent.
 - c. Solvent: Water.
 - d. Vehicle: Vinyl acrylic resin.
 - e. Weight per Gallon: 11.0 lbs.
 - f. Wet Film Thickness: 3.8 mils.
 - g. Dry Film Thickness: 1.3 mils.
 - h. Manufacturers: Benjamin Moore, ICI Dulux, Sherwin-Williams.
 - 3. Paint Type IAL-3: Interior Acrylic Latex, Semi gloss Enamel.
 - a. Solids by Weight: 49.0 percent.
 - b. Solids by Volume: 35.0 percent.
 - c. Solvent: Water.
 - d. Vehicle: Vinyl acrylic resin.
 - e. Weight per Gallon: 10.0 lbs.

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- f. Wet Film Thickness: 3.8 mils.
 - g. Dry Film Thickness: 1.2 mils.
 - h. Manufacturers: Benjamin Moore, ICI Dulux, Sherwin-Williams.
 - 4. Paint Type: class "A" fire rated paint, semi gloss (white)
 - a. Solids by Weight: 55.0 percent.
 - b. Solids by Volume: 40.0 percent.
 - c. Solvent: Water.
 - d. Vehicle: latex.
 - e. Weight per Gallon: 10.8 lbs.
 - f. Wet Film Thickness: 5.0 mils.
 - g. Dry Film Thickness: 2.0 mils.
 - h. Manufacturers: Flame Control Coatings (or equal)
 - 5. Paint Type ISP: Interior Steel Primer, Flat.
 - a. Solids by Weight: 72.0 percent.
 - b. Solids by Volume: 52.0 percent.
 - c. Vehicle: Alkyd resin.
 - d. Weight per Gallon: 11.4 lbs.
 - e. Wet Film Thickness: 3.0 mils.
 - f. Dry Film Thickness: 1.5 mils.
 - g. Manufacturers: PPG, Sherwin-Williams, Valspar.
 - 6. Paint Type ISP: Interior Primer, Flat. (flat grey)
 - a. Solids by Weight: 51.7 percent.
 - b. Solids by Volume: 38.1 percent.
 - c. Vehicle: Styronated acrylic..
 - d. Weight per Gallon: 10.5 lbs.
 - e. Wet Film Thickness: 5.0 mils.
 - f. Dry Film Thickness: 2.0 mils.
 - g. Manufacturers: Rustoleum (or equal)
- D. Heat Resistant Finish Paint Types:
 - 1. Paint Type HR-1: Ambient to 350 degrees Fahrenheit.
 - a. Solids by Volume: 40.0 percent.
 - b. Vehicle: Modified Silicone.
 - c. Weight per Gallon: 9.0lbs.
 - d. Wet Film Thickness: 2.5 mils.
 - e. Dry Film Thickness: 1.0 mils.
 - f. Manufacturers: Benjamin Moore, Insul-X, Rust-Oleum.
 - 2. Paint Type HR-2: 350 degrees Fahrenheit to 800 degrees Fahrenheit.
 - a. Solids by Volume: 34.0 percent.
 - b. Vehicle: Modified Silicone.
 - c. Weight per Gallon: 11.4 lbs.
 - d. Wet Film Thickness: 3.0 mils.
 - e. Dry Film Thickness: 1.5 mils.
 - f. Manufacturers: Benjamin Moore, Rust-Oleum, Sherwin-Williams.
 - 3. Paint Type HR-3: 800 degrees Fahrenheit to 1200 degrees Fahrenheit.
 - a. Solids by Volume: 30.0 percent.
 - b. Vehicle: 100 percent silicone.
 - c. Weight per Gallon: 9.0 lbs.
 - d. Wet Film Thickness: 3.0 mils.
 - e. Dry Film Thickness: 1.5 mils.

- f. Manufacturers: Benjamin Moore, Rust-Oleum, Sherwin-Williams.
- E. Other Finish Paint Types:
 - 1. Paint Type EIC: Elastomeric Insulation Coating, Acrylic Latex.
 - a. As manufactured or recommended by insulation manufacturer.
 - 1) Armstrong Armaflex Insulation: Use WB Armaflex Finish.
 - 2. Paint Type - Cycloaliphatic Epoxy.
 - a. Solids by Volume: 100 percent.
 - b. Vehicle: epoxy.
 - c. Weight per Gallon: 10.0 lbs.
 - d. Wet Film Thickness: 10/20 mils
 - e. Dry Film Thickness: 10/20 mils
 - f. Manufacturers: Epoxy-Coat
 - 3. Intumescent Paints (white)
 - a. Solids by Volume: 68. percent.
 - b. Vehicle: water based acrylic latex.
 - c. Weight per Gallon: 11.3 lbs.
 - d. Wet Film Thicknesses: (application chart)
 - e. Dry Film Thicknesses: (application chart)
 - f. Manufacturers: Contego High Solids Intumescent Paint.
 - g. Measurement gauge (to measure applied (wet) thickness of coating.
 - 3. Concrete Primer
 - a. Solids by Volume: 44.7 percent.
 - b. Vehicle: water based acrylic latex.
 - c. Weight per Gallon: 10.86 lbs.
 - d. Wet Film Thicknesses: 20 mils
 - e. Dry Film Thicknesses: 9 mils
 - f. Manufacturers: Sherwin Williams.
 - g. Measurement gauge (to measure applied (wet) thickness.
- F. Colors: (as applicable) Provide paint colors shown on contract drawings or to be selected by the Director from finish paint manufacturers available color selections.
 - 1. Approved finish paint manufacturers to match designated colors of other manufacturers where colors are shown on contract documents.
 - 2. Safety Colors: Industry Standard ANSI Safety Colors.
 - 3. Fire Protection Systems: Paint exposed piping, and handles of valves serving the system as specified below:
 - a. Sprinkler Systems: Red piping, and green valve handles.
 - b. Standpipe Systems: Red piping, and red valve handles.
 - c. Combination Sprinkler/Standpipe Systems: Red piping, and yellow valve handles.
 - 4. Color Coding: (As applicable) Apply exposed insulated and uninsulated piping finish paints in the following colors when piping is located in the following applicable rooms or spaces:
 - a. Applicable Rooms and Spaces: Mechanical Equipment Rooms, Steam Service Rooms, Refrigeration Machine Rooms, Boiler Rooms, Penthouse Mechanical Equipment Rooms and Power Houses.

- b. Existing Facility Buildings: Color code to match Facility's color code.
- c. New Facility Buildings: Color code as follows:
 - 1) Air, Compressed: Safety Green.
 - 2) Air, Control: Safety Green.
 - 3) Air, Medical: Safety yellow.
 - 4) Ammonia, Gas and Liquid: Safety Yellow.
 - 5) Brine: Safety Green.
 - 6) Carbon Dioxide: Safety Red.
 - 7) Dangerous Materials: Safety Yellow.
 - 8) Engine Exhausts: Safety Yellow.
 - 9) Fire Protection Systems; Fire Standpipe, Sprinkler, and Wet Chemical Systems: Safety Red.
 - 10) Flue Gases: Safety Yellow.
 - 11) Gas, Natural and Manufactured: Safety Yellow.
 - 12) Gasoline: Safety Yellow.
 - 13) Glycol and Glycol/Water Mixtures: Safety Yellow.
 - 14) Nitrous Oxide: Safety Blue.
 - 15) Oils, Fuel and Lubrications: Safety Yellow.
 - 16) Oxygen: Safety Green.
 - 17) Pneumatic Tube Systems: Safety Green.
 - 18) Refrigerants: Safety Yellow.
 - 19) Sewers, Storm and Sanitary: Safety Yellow.
 - 20) Steam; Supply, Condensate Return and Exhaust: Safety Yellow.
 - 21) Vacuum: Safety Green.
 - 22) Vent, Atmospheric: Safety Green.
 - 23) Water, Up to 140 Degrees Fahrenheit: Safety Green.
 - 24) Water, 141 Degrees and Above: Safety Yellow.
- d. Other Colors:
 - 1) Exposed Ductwork: Gray.
 - 2) Insulated and Uninsulated Equipment: Gray.
 - a) Do not paint equipment with factory finish paint.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine surfaces to be prepared, primed, or painted for compliance with contract documents, required environmental conditions, manufacturer's product data sheets, product label instructions and other written requirements.
 - 1. Do not begin any phase of the work without first checking and verifying that surfaces and environmental conditions are acceptable for such work and that any earlier phase deficiencies and discrepancies have been properly corrected. A manufacturer's representative is also required for this inspection for the type of paint (product) being applied.
 - a. The commencement of new work shall be interpreted to mean acceptance of surfaces to be affected.

3.02 PREPARATION

- A. Protection: Cover and protect surfaces to be painted, adjacent surfaces not to be painted, and removed furnishings and equipment from existing paint removals, airborne sanding particles, cleaning fluids and paint spills using suitable drop cloths, barriers and other protective devices.
 - 1. Adjacent exterior surface protections include roofs, walls, landscaping, driveways and walkways. Interior protections include floors, walls, furniture, furnishings and electronic equipment.
 - 2. Remove and replace removable hardware, lighting fixtures, telephone equipment, other devices and cover plates over concealed openings in substrates to be painted.
 - a. Cover and neatly mask permanently installed hardware, lighting fixtures, cover plates and other devices which cannot be removed and are not scheduled for painting.
 - 3. Schedule and coordinate surface preparations so as not to interfere with work of other trades or allow airborne sanding dust particle to fall on freshly painted surfaces.
 - 4. Provide adequate natural or mechanical ventilation to allow surfaces to be prepared and painted in accordance with product manufacturer's instructions and applicable regulations.
 - 5. Provide and maintain "Wet Paint" signs, temporary barriers and other protective devices necessary to protect prepared and freshly painted surfaces from damages until Work has been accepted.
- B. Clean and prepare surfaces to be painted in accordance with specifications, paint manufacturer's approved product data sheets and printed label instructions. In the event of conflicting instructions or directions, the more stringent requirements shall apply.
 - 1. Cleaners: Use only approved products manufactured or recommended by finish paint manufacturer. Unless otherwise recommended by cleaner manufacturer, thoroughly rinse with clean water to remove surface contaminants and cleaner residue.
- C. Surfaces:
 - 1. Existing Painted Substrates: Thoroughly clean to remove dirt, soot, grease, mildew, chalkiness and stains using finish paint manufacturer's recommended cleaners.
 - a. Remove loose, peeling, cracked and blistered paint by chipping, scraping, and sanding smooth with medium and fine sandpaper
 - b. Completely strip and remove existing paint films where shown on the drawings using approved methods. When approved, chemical strippers are to be applied and rinsed or removed in accordance with product manufacturer's printed instructions.
 - c. Fill surface holes and depressions with finish paint manufacturer's recommended filler and sand smooth to adjacent undisturbed edges.
 - d. Touch-up bare spots on previously painted surfaces with finish paint manufacturer's recommended primer.
 - e. Sand existing semigloss and gloss paint surfaces to a uniform smooth dull finish before painting.

- f. Fill and sand smooth existing paint surface damages, depressions, ridges and other imperfections that will remain visible after new paints have been applied.
 - 2. Steel Substrates:
 - a. Prepare steel in accordance with Structural Steel Painting Council (SSPC) standards:
 - 1) SSPC-SP1: Remove oil, grease, dirt, soil, salts, and other surface contaminants using appropriate cleaning solvents and clean rags, vapor, alkali, emulsion, or steam and adequate ventilation.
 - 2) SSPC-SP2: Remove loose rust, mill scale, and paint to the degree specified by hand chipping, scraping, sanding, and wire-brushing.
 - 3) SSPC-SP3: Remove loose rust, mill scale, and paint to the degree specified by power-tool chipping, descaling, sanding, wire-brushing, and grinding.
 - 4) SSPC-SP5: Remove all visible rust, mill scale, paint, and foreign matter by white-metal blast cleaning with wheel or nozzle (dry or wet) using sand, grit, or shot.
 - 5) SSPC-SP6: Remove all visible rust, mill scale, paint, and foreign matter by commercial blast cleaning until at least two-thirds of each element of the surface is free of all visible residues.
 - 6) SSPC-SP10: Near white blast cleaning for heat resistant paints.
 - 5. Galvanized Metal:
 - a. Allow new galvanized surfaces to weather as long as possible before cleaning. Remove surface contaminants using clean rags and petroleum spirits.
 - b. Remove “white rust” using appropriate solvent and, if necessary, wire brushing or sanding.
 - c. Use appropriate Structural Steel Painting Council Standard SSPC-SP1 to SSPC-SP6 to prepare steel substrates where galvanized protection has been removed.
 - 6. Aluminum:
 - a. Non-corroded Surfaces: Rub with fine steel wool and wipe clean with mineral spirits.
 - b. Corroded Surfaces: Sand smooth, rub with fine steel wool and wipe clean with mineral spirits.
- D. Painting Material Preparations:
 - 1. Prepare painting materials in accordance with manufacturer’s approved product data sheets and printed label instructions.
 - a. Stir materials before and during application for a consistent mixture of density. Remove container surface paint films before stirring and mixing.
 - b. Slightly tint first opaque finish coat where primer and finish coats are the same color.
 - c. Do not thin paints unless allowed and directed to do so in writing within limits stated on approved product data sheets.

3.03 PAINTING SCHEDULE

- A. Exterior Exposed Items: Unless otherwise specified, apply the following paint types with manufacturer's recommended primers on the following exterior substrates:
1. Paint Type EAL-3:
 - a. Uninsulated piping and ductwork.
 - b. Equipment hangers, supports and accessories for pipe and ductwork.
 2. Paint Type EIC:
 - a. Flexible elastomeric foam insulation on piping, ductwork, and equipment.
- B. (N/A) Exterior and Interior Exposed Fuel System Items: Unless otherwise specified, apply the following paint types with manufacturer's recommended primers on the following exterior and interior substrates.
1. Paint Type EAL-3:
 - a. Galvanized steel vent piping.
 - b. Galvanized steel piping except vent piping.
 - 1) Colors: As specified on Drawing No. _____ which is bound in Section _____.
 - c. Structural steel supports for fuel pump island dry chemical extinguishing system.
 - d. Pipe bollards.
 - 1) Color: Safety Yellow.
 - e. Fuel pump island fascia.
 - f. Manhole frames and lids, and fill caps; unless factory finished with appropriate A.P.I. color and symbol.
 - 1) Colors and Symbols: As specified on Drawing No. _____ which is bound in Section _____.
 2. Paint Type CTE:
 - a. Non-stainless steel exposed surfaces of hold down straps, turnbuckles, adjustment rods, wire rope, wire rope clamps, eye bolts, and anchor rods.
- C. Interior Exposed Items: Unless otherwise specified, apply the following paint types with manufacturer's recommended primers on the following interior substrates.
1. Paint Type IAL-3:
 - a. Insulated and uninsulated piping and ductwork.
 - b. Equipment hangars, supports and accessories for pipe and ductwork.
 - c. Hot and cold service equipment insulation.
 - d. Direct cast iron radiators.
 - e. Electrical raceways, fittings, pull boxes, junction boxes, etc.
 2. Paint Type IAL-4, on shop or factory primed substrates:
 - a. Type A service sinks.
 - b. Grease traps and interceptors.
 - c. Uninsulated mechanical equipment.
 - d. Cast iron fixture brackets.

- e. Metal fabrication in finished spaces.
- 3. Paint Type EIC:
 - a. Flexible elastomeric foam insulation on piping, ductwork, and equipment.
- 4. Paint Type HR-1, HR-2 or HR-3 to match substrate continuous and intermittent operational surface temperatures.
 - a. Uninsulated smoke flue pipe.
 - b. Uninsulated breeching.
 - c. Uninsulated exposed iron and steel boiler surfaces including steel casing, buck stays, boiler fronts, castings, smoke flue pipes, breeching, and exposed iron or steel surfaces installed in conjunction with boiler and incinerator Work.

3.04 APPLICATION

- A. Environmental Conditions:
 - 1. Water-based Paints: Apply when surface temperatures will be 60 degrees Fahrenheit to 85 degrees Fahrenheit throughout the drying period.
 - 2. Other Paints: Apply when surface temperatures will be 60 degrees Fahrenheit to 85 degrees Fahrenheit throughout the drying period.
 - 3. Apply exterior paints during daylight hours free from rain, snow, fog and mist when ambient air conditions are more than 5 degrees above the surface dewpoint temperature and relative humidity less than 70 percent.
 - a. When exterior painting is allowed or required during nondaylight hours, provide portable outdoor weather recording station with constant printout showing hourly to diurnal air temperature, humidity, and dewpoint temperature.
 - 4. Exterior Cold Weather Protection: Provide heated enclosures necessary to maintain specified temperature and relative humidity conditions during paint application and drying periods.
- B. Application: Apply approved paints where specified, or shown on the drawings, and to match approved field examples.
 - 1. Applicators: Brushes, rollers or spray equipment recommended by the paint manufacturer and appropriate for the location and surface area to be painted.
 - a. Approved minimum wet and dry film thicknesses for each coat shall be as recommended on approved product data sheets and the same for each application method and substrate.
- C. Paint Type Coats To Be Applied: Unless otherwise specified, or recommended by finish paint manufacturer's product data sheet and approved by submittal, the number of coats to be applied for each paint type are as follows:
 - 1. Acrylic Latex Paint Types EAL and IAL:
 - a. New Unpainted Surfaces: Apply 1 coat of primer and 2 coats of finish paint.
 - b. Existing Painted Surfaces:
 - 1) Apply 2 coats of finish paint when existing paint has a lower gloss.

- 2) Apply one coat of primer and 2 finish coats when existing paint has a higher gloss.
- c. Paint Type IAL: Provide mildewcide additive for bathrooms, kitchens, janitor closets, laundry rooms, restrooms and other wet or damp areas.
2. Paint Types ESP and ISP: Apply 1 coat.
 - a. Allow paint to dry one week and test adhesion. Remove and replace defective primer where adhesion failures occur.
3. Other Paint Types: Apply in accordance with paint manufacturer's product data sheets.

3.05 FIELD QUALITY CONTROL

- A. Paint Samples: Assist the Director's Representative in obtaining random one quart paint samples for testing at any time during the Work.
 1. Notify the Director's Representative upon delivery of paints to the Site.
 2. Furnish new one quart metal paint containers with tight fitting lids and suitable labels for marking.
 - a. Furnish labor to thoroughly mix paint before sampling and provide assistance with sampling when required.

3.06 ADJUSTING AND CLEANING

- A. Reinstall removed items after painting has been completed.
 1. Restore damaged items to a condition equal to or better than when removed. Replace damaged items that cannot be restored.
- B. Touch up and restore damaged finish paints. Touch up and restoration paint coats are in addition to the number of specified finish paint coats.
- C. Remove spilled, splashed, or spattered paint without marring, staining or damaging the surface. Restore damaged surfaces to the satisfaction of the Director's representative.
- D. Remove temporary barriers, masking tape, and other protective coverings upon completion of painting, cleaning and restoration work.

END OF SECTION

SECTION 230130

HVAC Air Duct Cleaning

PART 1 GENERAL

1.01 HEALTH AND SAFETY

- A. Safety Standards: cleaning contractors shall comply with all applicable federal, state and local requirements for protecting the safety of the contractors' employees, building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administration (OSHA) shall be followed when working in accordance with this specification.
- B. Occupant Safety: no processes or materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.
- C. Disposal of Debris: all Debris removed from the HVAC System shall be disposed of in accordance with applicable federal, state and local requirements.

1.02 QUALIFICATION OF THE HVAC SYSTEM CLEANING CONTRACTOR

- A. Membership: the HVAC system cleaning contractor shall be a certified member of the National Air Duct Cleaners Association (NADCA), or shall maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.
- B. Certification: the HVAC system cleaning contractor shall have a minimum of one (1) Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis, or shall have staff certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.
- C. Supervisor Qualifications: a person certified as an ASCS by NADCA, or maintaining an equivalent certification by a nationally recognized program and organization, shall be responsible for the total work herein specified.
- D. Experience: the HVAC system cleaning contractor shall submit records of experience in the field of HVAC system cleaning as requested by the Owner.
- E. Equipment, Materials and Labor: the HVAC system cleaning contractor shall possess and furnish all necessary equipment, materials and labor to adequately perform the specified services.
 - 1. The contractor shall assure that its employees have received safety equipment training, medical surveillance programs, individual health protection measures, and manufacturer's product and material safety data sheets (MSDS) as required for the work by the U. S. Occupational Safety and Health Administration, and as described by this specification.
 - 2. The contractor shall maintain a copy of all current MSDS documentation and safety certifications at the site at all times, as well as comply with all other site documentation requirements of applicable OSHA programs and this specification.
 - 3. Contractor shall submit to the Owner all Material Safety Data Sheets (MSDS) for all chemical products proposed to be used in the cleaning process.

1.03 ACCEPTABLE SUPPLIERS

- A. Ductworks
- B. As submitted and approved.

PART 2 HVAC SYSTEM CLEANING SPECIFICATIONS AND REQUIREMENTS

2.01 SCOPE OF WORK:

- A. Scope: this section defines the minimum requirements necessary to render HVAC components clean.

- B. The Contractor: shall be responsible for the removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.
- C. The HVAC system: includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system. The return air grilles, return air ducts (except ceiling plenums and mechanical room) to the air handling unit (AHU), the interior surfaces of the AHU, mixing box, coil compartment, condensate drain pans, humidifiers and dehumidifiers, supply air ducts, fans, fan housing, fan blades, air wash systems, spray eliminators, turning vanes, filters, filter housings, reheat coils, and supply diffusers are all considered part of the HVAC system.

2.02 IN SUMMARY THE CONTRACTOR SHALL CLEAN

- A. The full length of all supply air ducts
- B. The full length of all return air ducts
- C. The full length of all outside air ducts
- D. All supply and return air registers and diffusers
- E. All vertical shafts
- F. All air handlers including coils, blowers, filter racks, drain pans, and the entire interior of the air handler

PART 3 EXECUTION

3.01 GENERAL HVAC SYSTEM CLEANING REQUIREMENTS

- A. Containment: debris removed during cleaning shall be collected and precautions must be taken to ensure that Debris is not otherwise dispersed outside the HVAC system during the cleaning process.
- B. Particulate Collection: where the Particulate Collection Equipment is exhausting inside the building, HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or greater) particles shall be used. When the Particulate Collection Equipment is exhausting outside the building, Mechanical Cleaning operations shall be undertaken only with Particulate Collection Equipment in place, including adequate filtration to contain Debris removed from the HVAC system. When the Particulate Collection Equipment is exhausting outside the building, precautions shall be taken to locate the equipment down wind and away from all air intakes and other points of entry into the building.
- C. Controlling Odors: all reasonable measures shall be taken to control offensive odors and/or mist vapors during the cleaning process.
- D. Component Cleaning: cleaning methods shall be employed such that all HVAC system components must be Visibly Clean. Upon completion, all components must be returned to those settings recorded just prior to cleaning operations.
- E. Air-Volume Control Devices: dampers and any air-directional mechanical devices inside the HVAC system must have their position marked prior to cleaning and, upon completion, must be restored to their marked position.
- F. Service Openings: the contractor shall utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection.
 - 1. Contractor shall utilize the existing service openings already installed in the HVAC system where possible.
 - 2. Other openings shall be created where needed and they must be created so they can be sealed in accordance with industry codes and standards.
 - 3. Closures must not significantly hinder, restrict, or alter the air-flow within the system.
 - 4. Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces within the system.
 - 5. Openings must not compromise the structural integrity of the system.

6. Construction techniques used in the creation of openings should conform to requirements of applicable building and fire codes, and applicable NFPA, AMACNA and NADCA Standards.
 7. Cutting service openings into flexible duct is not permitted. Flexible duct shall be disconnected at the ends as needed for proper cleaning and inspection.
 8. Rigid fiber glass duct board duct systems shall be resealed in accordance with NAIMA recommended practices. Only closure techniques which comply with UL Standard 181 or UL Standard 181a are suitable for fiber glass duct system closures.
 9. All service openings capable of being re-opened for future inspection or remediation shall be clearly marked and shall have their location reported to the Owner in project report documents.
- G. Ceiling sections (tile): The contractor may remove and reinstall ceiling sections to gain access to HVAC systems during the cleaning process.
- H. Air distribution devices (registers, grilles & diffusers): The contractor shall clean all air distribution devices.
- I. Air handling units, terminal units (VAV, Dual duct boxes, etc.), blowers and fans: The contractor shall insure that supply and return fans and blowers are thoroughly cleaned. Areas to be cleaned include blowers, fan housings, plenums (except ceiling supply and return plenums), scrolls, blades, or vanes, shafts, baffles, dampers and drive assemblies. All visible surface contamination deposits shall be removed. Contractor shall:
1. Clean all air handling unit (AHU) internal surfaces, components and condensate collectors and drains.
 2. Assure that a suitable operative drainage system is in place prior to beginning wash down procedures.
 3. Clean all coils and related components, including evaporator fins.
- J. Duct Systems: Contractor Shall:
1. Create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas.
 2. Mechanically clean all duct systems to remove all visible contaminants, such that the systems are capable of passing Cleaning Verification Testing.

3.02 MECHANICAL CLEANING METHODOLOGY

- A. Source Removal Cleaning Methods: The HVAC system shall be cleaned using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select Source Removal methods which will render the HVAC system Visibly Clean and capable of passing cleaning verification methods. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.
1. All methods used shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device must be of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment are assured.
 2. All vacuum devices exhausting air inside the building shall be equipped with HEPA filters (minimum efficiency), including hand-held vacuums and wet-vacuums.
 3. All vacuum devices exhausting air outside the facility shall be equipped with Particulate Collection including adequate filtration to contain Debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate any outdoor environmental standard, codes or regulations.
 4. All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.

B. Methods of Cleaning Fibrous Glass Insulated Components:

1. Fibrous glass thermal or acoustical insulation elements present in any equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment, while the HVAC system is under constant negative pressure, and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.
2. Cleaning methods used shall not cause damage to fibrous glass components and will render the system capable of passing Cleaning Verification Tests.

C. Damaged Fibrous Glass Material:

1. If there is any evidence of damage, deterioration, delaminating, friable material, mold or fungus growth, or moisture such that fibrous glass materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating, they shall be identified for replacement.
2. When requested or specified, Contractor must be capable of remediating exposed damaged insulation in air handlers and/or ductwork requiring replacement.
3. Replacement Material: In the event fiber glass materials must be replaced, all materials shall conform to applicable industry codes and standards, including those of UL and SMACNA.
4. Replacement of damaged insulation is NOT covered by this specification.

D. Cleaning of coils

1. Any cleaning method may be used which will render the Coil Visible Clean. The drain for the condensate drain pan shall be operational. Cleaning methods shall not cause any appreciable damage to, displacement of, inhibit heat transfer, or erosion of the coil surface or fins, and shall conform to coil manufacturer recommendations when available. Coils shall be thoroughly rinsed with clean water to remove any latent residues.

E. Biocidal Agents and Coatings

1. Biocidal agents shall only be applied if active fungal growth is reasonably suspected, or where unacceptable levels of fungal contamination have been verified through testing.
2. Application of any biocide agent used to control the growth of fungal or bacteriological contaminants shall be performed after the removal of surface deposits and debris.
3. Only biocide agents registered by the U.S. Environmental Protection Agency (EPA) shall be used.
4. Biocidal agents shall be applied in strict accordance with manufacturer's instructions.
5. Biocidal coating products for both porous and non-porous surfaces shall be EPA registered water soluble solutions with supporting efficacy data and MSDS records.
6. Biocidal coatings shall be applied according to manufacturer's instructions. Coatings shall be sprayed directly onto interior ductwork surfaces, rather than "fogged" downstream onto surfaces. A continuous film must be achieved on the surface to be treated by the coating application. Application of any Biocidal coatings shall be in strict accordance with manufacturer's minimum surface application rate standards for effectiveness.
7. Inspection of Work Performed.

F. Contractor is to leave open all cleaning access points until they have been inspected by a representative of the County. The contractor can call for an inspection at any time.

G. Only after each opening has been inspected can the contractor seal up the cleaning access points.

H. The interior of the supply, return and outside air ducts must be visibly clean and pass inspection in order to satisfactorily complete the contract.

I. All air handlers need to be inspected before the access panels and doors are closed. All components of the air handlers must pass inspection in order to satisfactorily complete the project.

END OF SECTION 230130

SECTION 230523

VALVES (As Applicable)

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Temperature Control Valves: (N/A)

1.02 ABBREVIATIONS

- A. IBBM: Iron body, bronze mounted.
- B. OS&Y: Outside screw and yoke.
- C. WOG: Water, oil, gas.
- D. WSP: Working steam pressure.

1.03 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions for each valve type.
- B. Valve Schedule: List type of valve, manufacturer's model number, and size for each service application.

1.04 QUALITY ASSURANCE

- A. Source Quality Control:
 - 1. The Director, may at his discretion, require manufacturers to submit for approval mill certificates, laboratory test and manufacturing reports relating to chemical and mechanical properties of valve components.

1.05 MAINTENANCE

- A. Special Tools:
 - 1. One wrench for each type and size wrench operated plug valve.
 - 2. Two insert changing tools, and one spare insert for each self contained thermostatic radiator control valve.

PART 2 PRODUCTS

2.01 VALVES - GENERAL

- A. Valve Standardization: Valves from one or more manufacturers may be used, however valves supplied for each specific valve type shall be the product of one manufacturer.

- B. Valves shall be first quality, free from all imperfections and defects, with body markings indicating manufacturer and rating.
- C. Valve parts of same manufacturer, size and type shall be interchangeable.
- D. Manually operated gate, globe and angle valves shall be of rising stem type, unless otherwise specified.
- E. Manually operated valves shall open in a counterclockwise direction by means of round ventilated type handwheels.
 - 1. Exception: Cross handle type handwheels are acceptable for valves up to 3 inches in size.
- F. In open position, wedge and stem of gate valves shall clear the waterway completely.
- G. Valves which use packing shall be capable of being packed when wide open and under full working pressure.
- H. Size valves the same size as the piping in which they are installed, unless otherwise specified.

2.02 MATERIALS

- A. Body:
 - 1. Cast Iron: ASTM A 126 66, Class B, higher strength cast iron.
 - 2. Bronze: For use up to 150 psig WSP, ASTM B 62 and over 150 psig to 300 psig WSP, ASTM B 61.
 - 3. Cast Steel: ASTM A 216 Grade WCB.
 - 4. Forged Steel: ASTM A 105 Grade 2.
- B. Stem:
 - 1. Cast Manganese Bronze: ASTM B 584.
 - 2. Cast Silicon Brass: ASTM B 584.
 - 3. Rolled Silicon Brass: ASTM B 98 Alloy D.
 - 4. Rolled Aluminum Bronze: ASTM B 150 Alloy 1.
 - 5. Rolled Manganese Bronze: ASTM B 138 Alloy A (half hard).
 - 6. Naval Brass: ASTM B 21 Alloy A or Alloy C (hard).
 - 7. Carbon Steel: As specified for particular type of valve.
 - 8. Stainless Steel: As specified for particular type of valve.
- C. Trim: As specified for particular type of valve.

2.03 GATE VALVES

- A. Type A: 125 psig WSP, 200 psig WOG, bronze body, union bonnet, solid wedge disc, and threaded ends. Acceptable Valves: Crane 428UB, Hammond IB617, Jenkins 47CU, Milwaukee 1152, Nibco T134, and Stockham B105.

- B. Type C: 125 psig WSP, 200 psig WOG up to 12 inch size, and 150 psig WOG for 14 inch and 16 inch sizes; IBBM OS&Y, bolted bonnet, solid wedge disc, and threaded or flanged ends depending on size. Acceptable Valves: Crane 464-1/2 & 465-1/2, Hammond IR1140, Milwaukee F2885, Nibco T6170 & F6170, and Stockham G620 & G623
- C. Type D: 125 psig WSP, 200 psig WOG, bronze body, threaded bonnet, solid wedge disc, and solder ends. Acceptable Valves: Crane 1330, Hammond IB635, Jenkins 991AJ, Milwaukee 149, Nibco S111, and Stockham B108.
- D. Type E: 200 psig WSP, 400 psig WOG, bronze body, union or bolted bonnet, solid wedge disc, with monel, cupro-nickel alloy or stainless steel seat rings, and threaded ends. Acceptable Valves: Crane 424, Hammond IB650, Jenkins 2270UJ, Milwaukee 1174, Nibco T174SS, and Stockham B132.
- E. Type F: 250 psig WSP, 500 psig WOG up to 12 inch size, and 200 psig WSP, 300 psig WOG for 14 inch thru 20 inch sizes, IBBM OS&Y, bolted bonnet, solid wedge disc, and threaded or flanged ends depending on size. Acceptable Valves: Crane 7-1/2, Hammond IR330, Jenkins 204C, Milwaukee F2894, Nibco F6670, and Stockham F667.
- F. Type G: 300 psig WSP, 600 psig WOG, bronze body, union or bolted bonnet, solid wedge disc, cupro-nickel alloy or stainless steel seat rings, and threaded ends. Acceptable Valves: Crane 634E, Hammond IB658, Jenkins 2280UJ, Milwaukee 1184, Nibco T174SS, and Stockham B145.
- G. Type H: 150 psig WSP, 300 psig WOG, bronze body, union bonnet, solid wedge disc, and threaded ends. Acceptable Valves: Crane 431UB, Hammond IB629, Jenkins 47CU, Milwaukee 1151, Nibco T134, and Stockham B120.
- H. Type I: 150 psig WSP, 300 psig WOG, bronze body, union bonnet, solid wedge disc, and solder ends. Acceptable Valves: Hammond IB648, Milwaukee 1169, and Nibco S134.

2.04 GLOBE AND ANGLE VALVES

- A. Type J: 125 WSP, 200 psig WOG, bronze body, threaded bonnet, and threaded ends. Acceptable Valves: Crane 1, Hammond IB440 & IB463, Jenkins 101J, Milwaukee 502, Nibco T211 & T311, and Stockham B16.
- B. Type K: 125 psig WSP, 200 psig WOG, IBBM OS&Y, bolted bonnet, and threaded or flanged ends depending on size. Acceptable Valves: Crane 351 & 353, Hammond IR116, Jenkins 613C & 615C, Milwaukee F2981, Nibco F718B & F818B, and Stockham G512, & G515.
- C. Type L: 200 psig WSP, 400 psig WOG, bronze body, union or bolted bonnet, with 500 Brinell hardness stainless steel renewable plug, 500 Brinell hardness stainless steel replaceable seat ring, and threaded or flanged ends depending on size. Acceptable Valves: Crane 212P, Hammond IB434, Jenkins 2050J, Milwaukee 592 & 593, Nibco T276AP & T376AP, and Stockham B62.

- D. Type M: 250 psig WSP, 500 psig WOG, IBBM OS&Y, bolted bonnet, renewable seat and disc, and threaded or flanged ends depending on size. Acceptable Valves: Crane 21E, Hammond IR313, Jenkins 923C, Milwaukee F2983, Nibco F768B & F869B, and Stockham F532.
- E. Type N: 300 psig WSP, 600 psig WOG, bronze body, union bonnet, with 500 Brinell hardness stainless steel renewable plug, 500 Brinell hardness stainless steel replaceable seat ring, and threaded or flanged ends depending on size. Acceptable Valves: Crane 382P & 384P, Hammond IB444, Jenkins 556P & 558P, Milwaukee 593A, Nibco T276AP & T376AP, and Stockham B74 & B274.
- F. Type O: 125 psig, 200 psig WOG, bronze body, threaded bonnet, and solder ends. Acceptable Valves: Crane 1310, Hammond IB423, Jenkins 1200C, Milwaukee 1502, Nibco S211, and Stockham B17.
- G. Type P: 150 psig WSP, 300 psig WOG, bronze body, union bonnet, threaded ends, with 500 Brinell hardness stainless steel renewable plug and replaceable seat ring. Acceptable Valves: Crane 14-1/2, Hammond 444, Jenkins 2032J, Milwaukee 591A, and Stockham B29.

2.05 CHECK VALVES

- A. Type S: 125 psig WSP, 200 psig WOG, bronze body, brass or bronze trim, horizontal swing, renewable and regrindable disc, and threaded ends. Face discs for cold water service with teflon. Acceptable Valves: Crane 37, Hammond IB940, Jenkins 4092, Milwaukee 509, Nibco T413Y, and Stockham B319Y.
- B. Type T: 150 psig WSP, 300 psig WOG, bronze body, brass or bronze trim, horizontal swing, renewable and regrindable disc, and threaded ends. Face discs for cold water service with Buna-N or teflon. Acceptable Valves: Crane 137, Hammond IB944, Jenkins 4092 & 4037J, Nibco T4331, and Stockham B321.
- C. Type U: 125 psig WSP, 200 psig WOG, bronze body, brass or bronze trim, horizontal swing, renewable and regrindable disc, and solder ends. Face discs for cold water service with teflon. Acceptable Valves: Crane 1340, Hammond IB912, Jenkins 4093, Milwaukee 1509, Nibco S413Y, and Stockham 309Y.
- D. Type V: 125 psig WSP, 200 psig WOG, IBBM, horizontal swing, bolted bonnet, regrindable and renewable seat ring and disc, and threaded or flanged ends depending on size. Discs on valves 4 inch size and larger may be cast iron with bronze face. Acceptable Valves: Crane 372, & 373, Hammond IR1124, Jenkins 623CJ & 624CJ, Milwaukee F2974, Nibco F918, and Stockham G927 & G931.
- E. Type W:
 - 1. Globe Style Silent Check Valve: IBBM or semi-steel with bronze mounting, renewable seat and disc, 18-8 stainless steel spring, and flanged ends.
 - a. Acceptable Valves (125 psig flange pressure rating): Apco Series 600, Combination Pump & Valve 20D, Hammond IR9354, Milwaukee 1800, Nibco F910, and Williams Hager 636.

- b. Acceptable Valves (250 psig flange pressure rating): Apco Series 600, Combination Pump & Valve 21D, Milwaukee 1800, Nibco F960, and Williams Hager 636.
 - 2. Wafer Style Silent Check Valve: IBBM or semi-steel with bronze mounting, renewable seat and disc, 18-8 stainless steel spring, and flanged ends.
 - a. Acceptable Valves (125 psig flange pressure rating): Apco Series 300, Combination Pump and Valve 10D, Hammond IR9253, Milwaukee 1400, Nibco W910, and Williams Hager 329 & 375.
 - b. Acceptable Valves (250 psig flange pressure rating): Apco Series 300, Combination Pump and Valve 11D, Milwaukee 1400, Nibco W960, and Williams Hager 329 & 375.
- F. Type X: 300 WSP, 600 psig WOG, bronze body, brass or bronze trim, horizontal swing, renewable and regrindable disc, and threaded ends. Face disc for cold water service with Buna-N or teflon. Acceptable Valves: Crane 76E, Hammond IB949, Jenkins 4962J, Milwaukee 507, Nibco T4731, and Stockham B375.
- G. Type Y: 250 psig WSP, 500 psig WOG, IBBM, horizontal swing, bolted bonnet, regrindable and renewable seat ring and disc, and threaded or flanged ends depending on size. Discs on valves 4 inch size and larger may be cast iron with bronze face. Acceptable Valves: Crane 39E, Hammond IR322, Jenkins 339C, Milwaukee F2970, Nibco F968B, and Stockham F947.
- H. Type Z: 125 psig flange pressure rating, cast iron body, wafer style, split clapper plate type with integral body seat ring, plain or flat face end connections, resilient Buna-N seal vulcanized to body seat ring; aluminum, bronze or stainless steel clapper plates; Type 316 stainless steel clapper springs and hinge pins; and nickel plated steel or stainless steel stop pieces. Acceptable Valves: Apco Series 9000, Nibco W920W, Stockham WG970, and Marlin Duo-Check II.

2.06 PLUG VALVES

- A. Type AA: 200 psig WOG, lubricated type with standard port opening, cast iron or semi-steel body, sealed lubrication system with lubricant fitting and dial indicator, cylindrical plug or teflon tapered plug, lubricant grooves in body or plug, threaded or flanged ends depending on size, and capable of lubrication with valve under pressure and plug in any position.
 - 1. Acceptable Valves:
 - a. 1/2 inch to 3 inch size: Homestead 611 & 612, Resun R1430 & R1431, and Rockwell 142 & 143.
 - b. 4 inch size: Homestead 611 & 612, , Resun R1430 & R1431, and Rockwell 142 & 143.
 - c. 5 inch size: Homestead 611 & 612, Resun R1431, and Rockwell 143.
 - d. 6 inch size: Homestead 611 & 612, , Resun R1431, and Rockwell 143.
 - e. 8, 10 & 12 inch sizes: Homestead 612G, Resun R1431WGA, and Rockwell 149.
 - 2. Operators:

- a. 6 inch size and Less: Wrench operator.
 - b. 8 inch size and Up: Worm gear operator.
- B. Type AB: 100 psig WOG, gas cock type with cast iron or bronze body, bronze plug, square head, wrench operator, and threaded ends. Acceptable Manufacturers: Crane, Eclipse Combustion, and McDonald.

2.07 BUTTERFLY VALVES

- A. Type BF: Iron body, flangeless wafer or lugged type, (lug for each bolt hole, drilled and tapped for cap screws), with replaceable reinforced resilient EPT (EPDM) seats, bronze or nickel plated ductile iron discs, phosphate coated steel or stainless steel stems, and raised necks able to accommodate 2 inches of insulation. Acceptable Manufacturers: Crane, Demco, De Zurik, Hammond, Keystone, Milwaukee, Nibco, Stockham, and Watts.
 - 1. Pressure Ratings:
 - a. 12 inch size and Less: 200 psig WOG at 275 degrees F.
 - b. 14 inch size and Up: 150 psig WOG at 275 degrees F.
- B. Type BF-HP: ANSI Class 150 lug style carbon steel body, stainless steel disc and stem, RTFE seats and bushings. Acceptable Manufacturers: Crane, Hammond, Keystone, Milwaukee, and Stockham.
- C. Operators:
 - 1. 6 inch size and Less: Manual actuator handles with external indication of disc position, and suitable means of locking actuator in any fixed position.
 - 2. 8 inch size and Up: Worm gear operator.

2.08 COMBINATION BALANCING AND SHUT-OFF VALVES

- A. Heavy duty brass construction of angle or straightway pattern with 200 psig working water pressure at 250 degrees F, one union connection and one threaded or solder end, visible graduated dial indicator, memory stop, and wheel handle with full turn opening. Acceptable Manufacturers: Dunham-Bush, and Spirax Sarco.

2.09 REFRIGERANT VALVES

- A. Valves shall have forged brass or bronze bodies, conforming to ASME B31.5 Code for Refrigerant Piping. Acceptable Manufacturers: Henry, Mueller, and Superior.
- B. Type RG: Stop valve of the globe or angle design.
 - 1. 5/8 inch od and Less: Packless metal diaphragm valve with solder type or flared ends.
 - 2. 3/4 inch od and Up: Packed backseating valve with wing cap seal with stem operating socket formed in top, and solder type ends.

- C. Type RH: Purge, drain or refrigerant charging valve of angle or globe design, with packless metal diaphragm with flared ends, and removable seal cap chained to valve body.
- D. Type RI: Fusible plug valve with a melting point of fusible metal approximately 212 degrees F., conforming to ASHRAE 15 Code for Mechanical Refrigeration.
- E. Type RJ: Relief valve conforming to ASHRAE 15 Code for Mechanical Refrigeration.
- F. Type RK: Check valve of spring operated, guided piston type with flared ends in sizes thru 5/8 inch od, and solder type ends in sizes through 7/8 inch od.
- G. Type RL: Check valve of spring operated, guided piston type with bolted bonnet or cover plate, and solder type ends in sizes 1-1/8 inch od thru 4-1/8 inch od.

2.10 CAST OR FORGED STEEL VALVES

- A. Gate Valves:
 - 1. Type GV-4: Cast steel body, bolted bonnet, OS & Y, rising stem, solid wedge, flanged ends, Class 300 built for 270 psig at 850 degrees F.
 - a. Body and Bonnet: Cast steel.
 - b. Stem: Stainless steel (18-8 or CR 13).
 - c. Seat Rings: Copper nickel alloy or monel.
 - d. Wedge: Steel with stainless steel face hardened.
 - e. Bonnet Gasket: Spiral wound stainless steel with 316 spiral wound graphite, minimum of six packing rings.
 - f. Handwheel: Steel or malleable iron.
 - 2. Type GV-6: Cast steel body, bolted bonnet, OS & Y, rising stem, solid wedge, welding ends, Class 300 built for 270 psig at 850 degrees F.
 - a. Body and Bonnet: Cast steel.
 - b. Stem: Stainless steel (18-8 or CR 13).
 - c. Seat Rings: Copper nickel alloy or monel.
 - d. Wedge: Steel with stainless steel face hardened.
 - e. Bonnet Gasket: Spiral wound stainless steel with 316 spiral wound graphite, minimum of six packing rings.
 - f. Handwheel: Steel or malleable iron.
 - 3. Type GV-7: Forged steel body, bolted bonnet, OS & Y, rising stem, solid wedge, threaded ends, Class 800 built for 715 psig at 850 degrees F.
 - a. Body and Bonnet: Forged steel.
 - b. Stem: Stainless steel (18-8 or CR 13).
 - c. Seat Ring: Stainless steel, seat hardened to 400 Brinell.
 - d. Wedge: Stainless steel surface hardened to 400 Brinell.
 - e. Bonnet Gasket: Spiral wound stainless steel with 316 spiral wound graphite, minimum of six packing rings.
 - f. Handwheel: Steel or malleable iron.
 - 4. Type GV-8: Forged steel body, bolted bonnet, OS & Y, rising stem, solid wedge, welding ends, Class 800 built for 715 psig at 850 degrees F.
 - a. Body and Bonnet: Forged steel.
 - b. Stem: Stainless steel (18-18 or CR 13).

- c. Seat Ring: Stainless steel, seat hardened to 400 Brinnel.
- d. Wedge: Stainless steel surface hardened to 400 Brinnel.
- e. Bonnet Gasket: Spiral wound stainless steel with 316 spiral wound graphite, minimum of six packing rings.
- f. Handwheel: Steel or malleable iron.

B. Angle and Globe Valves:

- 1. Type AV-4: Cast steel body, bolted bonnet, OS & Y, rising stem, flanged ends, Class 300 built for 270 psig at 850 degrees F.
 - a. Body and Bonnet: Cast steel.
 - b. Stem: Stainless steel (18-8 or CR 13).
 - c. Seats and Disc: Copper nickel alloy or monel in combination with stainless steel. Disc shall be renewable.
 - d. Bonnet Gasket: Spiral wound stainless steel with 316 spiral wound graphite, minimum of six packing rings.
 - e. Handwheel: Steel or malleable iron.
- 2. Type AV-6: Cast steel body, bolted bonnet, OS & Y, rising stem, welding ends, Class 800 built for 715 psig at 850 degrees F.
 - a. Body and Bonnet: Cast steel.
 - b. Stem: Stainless steel (18-8 or CR 13).
 - c. Seats and Disc: Copper nickel alloy or monel in combination with stainless steel. Disc shall be renewable.
 - d. Bonnet Gasket: Spiral wound stainless steel with 316 spiral wound graphite, minimum of six packing rings.
 - e. Handwheel: Steel or malleable iron.
- 3. Type AV-7: Forged steel body, bolted bonnet, OS & Y, rising stem, threaded ends, Class 800 built for 715 psig at 850 degrees F.
 - a. Body and Bonnet: Forged steel.
 - b. Stem: Stainless steel (18-8 or CR 13).
 - c. Seat Ring: Stainless steel hardened to 400 Brinnel.
 - d. Disc: Renewable plug type, stainless steel hardened to 500 Brinnel.
 - e. Bonnet Gasket: Spiral wound stainless steel with 316 spiral wound graphite, a minimum of six packing rings.
 - f. Handwheel: Steel or malleable iron.
- 4. AV-8: Forged steel body, bolted bonnet, OS & Y, rising stem, welding ends, Class 800 built for 715 psig at 850 degrees F.
 - a. Body and Bonnet: Forged steel.
 - b. Stem: Stainless steel (18-8 or CR 13).
 - c. Seat Ring: Stainless steel hardened to 400 Brinnel.
 - d. Disc: Renewable plug type, stainless steel hardened to 500 Brinnel.
 - e. Bonnet Gasket: Spiral wound stainless steel with 316 spiral wound graphite, a minimum of six packing rings.
 - f. Handwheel: Steel or malleable iron.

C. Check Valves:

- 1. Type CV-4: Horizontal swing check, cast steel body and bolted cap, flanged ends, Class 300 built for 270 psig at 850 degrees F. Disc shall be heavy one piece construction, suspended on a detachable hinge with detachable hinge pin.

- a. Body and Cap: Cast steel.
 - b. Seat Ring: Stainless steel.
 - c. Disc: Stainless steel and renewable.
 - d. Hinge Pin: Stainless steel and renewable.
 - e. Gasket: Soft corrugated iron.
 2. Type CV-17: Lift check, forged steel body and bolted or union type cap, welding ends, Class 600 built for 535 psig at 850 degrees F.
 - a. Body and cap: forged steel.
 - b. Seat ring: stainless steel.
 - c. Disc: stainless and renewable.
 - d. Gasket: Spiral wound stainless steel with 316 spiral wound graphite.
 3. Type CV-19: Ball check, forged steel body, bolted cap, threaded ends, Class 600 built for 535 psig at 850 degrees F.
 - a. Body and Cap: Forged steel.
 - b. Seat Ring: Stainless steel.
 - c. Ball: Stainless steel.
 - d. Gasket: Soft corrugated iron.
 4. Type CV-21: Silent check, cast steel body, stainless steel trim and spring, flanged ends, Class 300 built for 270 psig at 850 degrees F.
 - a. Center guided or globe design with spring controlled closing action in which disc is returned to seat at zero velocity or before reversal of flow takes place in pipe line.
 - b. Disc shall be free floating controlled by velocity of flow, without aid of grease or counterweight balance for operation.
 - c. Check valve shall be designed to prevent grinding of seat and disc after factory assembly.
- D. Stop-Check Valve:
1. Type SC-1: Angle valve, cast steel body, bolted bonnet, OS & Y, rising stem, flanged ends, built for 300 psig at 850 degrees F., 1100 psig hydrostatic shell tests, conforming to ASME Boiler Code. Valve shall be disc guided by piston or sleeve on stem, with deep packing box- minimum of 6 packing rings. Piston shall be fitted with corrosion resistant piston rings or lapped surface properly fitted in the valve body. Valve with disc guided by a sleeve on stem shall be complete with outside spring and lever assembly to cushion movement of valve disc, and shall have a lower disc guide to insure proper seating of disc.
Materials:
 - a. Body and Bonnet: Cast steel.
 - b. Stem: Stainless steel (18-8 or CR 13).
 - c. Body Seat Ring: Stainless steel. Valves with integral welded seats are acceptable providing seat material is either stainless steel or stellite.
 - d. Disc: Stainless steel or stellite.
 - e. Piston Rings: Stainless steel or equivalent corrosion resistant material, as approved.
 - f. Bonnet Gasket: Soft corrugated iron.
 - g. Handwheel: Cast steel or malleable iron. 10-inch size and larger shall have impact type handwheels.

2. Type SC-2: Angle or globe valve, IBBM OS & Y, 250 psig WSP, 500 psig WOG, bolted bonnet, rising stem, and flanged ends.

E. Blow-off Valves:

1. Type BO-1: Angle or straight-away, seatless hollow plunger type, cast steel body and yoke, non-rising stem, flanged ends, Class 300 built for 270 psig at 850 degrees F., boiler MAWP of 515 psig, conforming to ASME Boiler Code. Bolted yoke shall have ball thrust bearing and heavy coil compression springs under yoke nuts. Valve shall be protected from leakage by packing rings above and below the inlet port. When valves are used in tandem, each shall have a "Caution Plate" attached noting valve operation sequence. Materials:
 - a. Body and Yoke: Cast steel.
 - b. Plunger: Nitralloy with meehanite head and cold drawn steel stem. Surface hardness of plunger shall be a minimum of 1050 Brinell.
 - c. Packing Rings: John Crane 387i braided graphite.
 - d. Handwheel: Cast iron.
2. Type BO-2: Unit tandem type, consisting of a seatless valve with flanged ends as specified for Type BO-1 and a disc and seat as specified for BO-3, built for 300 psig at 850 degrees F., boiler MAWP of 515 psig, conforming to ASME Boiler Code.
3. Type BO-3: Angle or straight-away, disc and seat type, steel body and bolted bonnet, OS & Y, stellited seat integral with body, disc of alloy as approved, hardened polished stainless steel stem, flanged ends, built for 300 psig at 850 degrees F., boiler MAWP of 515 psig, conforming to ASME Boiler Code. When valves are used in tandem, each shall have a "Caution Plate" attached noting valve operation sequence.
4. Type BO-4: Angle or straight-away, disc and set type, steel body and bolted bonnet, OS & Y, stellited seat integral with body, disc of alloy as approved, hardened polished stainless steel stem, welding ends, built for 300 psig at 850 degrees F., boiler MAWP of 515 psig, conforming to ASME Boiler Code. When valves are used in tandem, each shall have a "Caution Plate" attached noting valve operation sequence.

F. Blow-Down Valve:

1. Type BO-5: High pressure drop valve, designed for continuous blow-down, 1 inch in size, threaded or socket weld ends, built for 600 psig WSP at 900 degrees F. Valve shall be single orifice, needle stem. Orifice tube shall be selected to suit boiler pressure and pounds of blow-down per hour. Materials:
 - a. Body and Bonnet: Forged steel.
 - b. Stem: Stainless steel, with a stellite or equivalent as approved material seat.
 - c. Orifice Tube: Stainless steel, with a stellite or equivalent as approved material facing.
 - d. Miscellaneous Trim: Such as threaded bushing, packing gland, packing gland bolts, pins shall be stainless steel.
 - e. Dial, Dial Plate, Indicator Bracket, Indicator Plate and Screws: Brass.

2. Type BO-6: Multiple orifice, continuous blow-down flow control unit, consisting of body with top body casting, orifice plate, rotating selector disc, index head, sediment chamber, shut-off plug valve, and all required fittings, assembled in a single unit, built for MAWP of 250 psig WSP. Orifice plate shall be stainless steel, head treated to 500 Brinell hardness and surface lapped to a mirror finish and flatness tolerance of approximately 3 light bands.

G. Back Pressure Valve:

1. Type BP-1: Multiport relief, cast iron housing, with bronze valve discs and piston set assemblies, carbon steel springs, flanged ends, built for 300 degrees F. maximum temperature, suited for a range of from 0 to 25 psig pressure. Flanges shall be 125 psig ANSI iron standard, faced and drilled.

2.11 WATER PRESSURE REDUCING VALVES

A. Main Water Service:

1. Valve shall be an adjustable, direct acting, spring loaded, diaphragm operated, single seat, bottom guided type suitable for dead end service; guaranteed not to stick and shall maintain a constant discharge pressure which will not vary more than 1 psig for each 10 psig decrease in inlet pressure. Valves shall have cast iron, mild steel or bronze bodies, with either flanged ends or screwed ends with unions. Valve trim shall be of stainless steel with renewable composition disc. Parts subject to wear shall be renewable.
2. Material of diaphragm and disc shall be suitable for an operating temperature to 150 degrees F. The control line, from diaphragm casing, shall be connected to the discharge piping at least 10 feet downstream from pressure reducing valve. Control line shall be of same material as adjoining piping. Valves shall be standard weight for inlet pressures up to 125 psig, and extra heavy weight for inlet pressures in excess of 125 psig.
3. Acceptable Valves: Fisher Governor Type 655A, Kieley Mueller Type 4250.

B. Cold Water Make-Up Service:

1. Adjustable direct acting, spring loaded, diaphragm operated, single seat type conforming to ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Domestic Water Supply Systems. Acceptable Manufacturers: Bell & Gossett, Watts, and Wilkins.
 - a. Body: Brass or bronze construction.
 - b. Wetted Parts: Brass, bronze, stainless steel, or nickel alloy construction.
 - c. Renewable seat and removable composition disc.
 - d. Integral low inlet pressure check valve.
 - e. Operating Temperature Range: 33-160 degrees F.
 - f. Maximum Working Pressure: 125 psi.
2. Pressure reducing valves with integral strainers may be substituted for approval, in lieu of separate valve and strainer, if integral strainer and valve meet individual valve and strainer specifications.

2.12 STEAM PRESSURE REDUCING VALVES

- A. External Pilot Operated Type:
1. Valve shall be single seated, suitable for dead end service, without stuffing boxes. Pilot shall have an adjustable range spring and shall operate main valve by positioning pilot valve. Output of pilot valve shall position a piston or diaphragm in main valve. Control line for pilot shall be connected to discharge piping at least 10 feet downstream from main valve.
 2. Pressure Classification:
 - a. Inlet pressures up to 15 psig incl. - low pressure - standard weight body.
 - b. Inlet pressures from 16 psig to 125 psig incl. - medium pressure - standard weight body.
 - c. Inlet pressures over 125 psig - high pressure - extra heavy body.
 3. Construction: Valves shall have stainless steel trim with laminated bronze or stainless steel diaphragms. Main valve plug and seat shall be stainless steel, with seat rings and plugs of the easily removable and renewable type. Internal pilot type valves shall have removable bottom guides of stainless steel for main valve plug. Each pilot shall have an integral inlet strainer with stainless steel screen. Valves without integral inlet pilot valve strainers, shall be provided with a separate strainer with stainless steel screen, in control line to pilot. Valves 2 inches in size and smaller shall have screw ends, and over 2 inches in size shall have flanged ends. Screwed end valves shall be provided with a union on both sides of the valve.
 4. Service Requirements: Each valve shall be guaranteed to maintain a discharge pressure which will not vary more than 5 percent from pressure setting. Should supply pressure deviate from design conditions, discharge pressure shall not vary more than 1 psi for each 30 psi change in inlet pressure. Valves shall be capable of handling a sudden load change, equivalent to 75 percent of its maximum capacity rating, within a period of 5 seconds and shall stabilize to set pressure within 10 seconds from initial start of this load change. Valves shall be adjustable for 50 percent above and 50 percent below set pressure, without changing pilot range spring.
- B. Self-Contained Pressure Reducing Valve Without Pilot: A self-contained valve, without pilot, may be used when the maximum flow rate through the valve is 200 pounds of steam per hour or less. Valves shall, in general, conform to the requirements for classification and construction specified for the external pilot operated type. Valve shall maintain a discharge pressure within 20 percent of set pressure, at maximum flow.

2.13 STEAM PRESSURE REDUCING VALVES (PNEUMATICALLY OPERATED)

- A. General Requirements: Each valve assembly shall consist of a diaphragm actuated main valve pneumatically operated by a control pilot, located on a remote control panel. Main valves shall be of equal percentage V-port type, with a rangeability of 50 to 1. When reduced port size (Cv index) and body size for a

particular pressure reducing valve is not available for manufacturers listed valve body size and model, a liner modified parabolic or modified linear V-port type, with a minimum rangeability of 30 to 1 as recommended and guaranteed by valve manufacturer, may be submitted for approval. Main valves shall regulate accurately throughout range of pressure and flow conditions, and shall close on air failure. Acceptable Manufacturers: Fisher Governor, Honeywell and Kieley Mueller.

- B. Pressure Classification:
 - 1. Inlet Pressures Up To 100 psig Incl.: Cast iron body, built for 125 psig WSP.
 - 2. Inlet Pressures 101 To 200 psig: Cast steel or nodular iron body, as recommended by the valve manufacturer, built for 300 psig WSP.
- C. Sizing of Valves: Each pressure reducing valve shall be complete with required reduced trim, so that valve will have a Cv index, for specified flow in pounds of steam per hour, for its respective inlet and discharge pressure as indicated. Each valve shall have a body size, so as to result in a maximum outlet velocity of 25,000 fpm for body sizes 2 inches and under, and 23,000 fpm for valves over 2 inches in size. Valve Cv coefficients shall be so stated on shop drawing submissions.
- D. Main Valve: Globe or cage type body, flanged ends, with face-to-face dimensions as recommended by the I.S.A. Seating surfaces on valve plug and seat ring, ringed with Alloy No. 6 or 17-4P-H trim. Plug and valve stem shall have top and bottom guides, or full sleeves guides, or be cage guided for body sizes of 1 inch and larger. Plug, seat, top guide and bottom guide or cage shall be renewable. Valve stem shall have a travel indicator and each valve shall have spring-loaded teflon packing. Diaphragm shall be neoprene and main valve shall be normally closed when control pressure on diaphragm is 3 psig or less.
- E. Control Pilot: Indicating bourdon tube type with escape nozzle, flapper valve, proportioning bellows and calibrated pressure setting dial, proportional band adjustment, with feed back for sensitivity and pneumatic relay with differential diaphragms. Each control pilot shall have an air supply gage, air loading gage and a downstream delivery pressure gage, which shall constantly indicate controlled steam pressure.
 - 1. Control pilot shall have a 2 to 200 percent proportional control band with automatic reset control mode and a sensitivity adjustment of not less than 0.1 of full scale at 100 percent proportional band, and shall have a direct setting knob.
 - 2. Control pilot shall be enclosed in an aluminum die cast case and cover. Enclosure shall be complete with dust seal, deep waterproof gaskets, captive stainless steel hinge pins and latch shaft. Enclosure case shall be designed for flush mounting on a remote panel board.
 - 3. Control pilot shall be Fisher Wizard 11 Type 4160 or United States Gage Figure 10.
- F. Valve Positioner: Each valve positioner shall have travel adjustment; ready reversible action and shall contain an air escape device with a force balancing spring acting on an air bellows, all enclosed in an aluminum die cast case with

connecting linkage. Furnish each positioner with an integral by-pass valve and 3 air pressure gages for indicating supply, loading and outlet pressure. Positioner shall be Moore Model 72, Fisher Governor Type 3580.

- G. Air Set: Consisting of a filter-regulator suitable for 150 psig inlet pressure, with adjustable reduced range of 5 to 35 psig, complete with drip well, shall be provided for each pressure reducing valve assembly.

2.14 PNEUMATICALLY ACTIVATED CONTROL VALVES

- A. General Requirements: Each valve assembly shall consist of a diaphragm actuated main valve, pneumatically operated by a control pilot or controller, located on a remote control panel. Valve positioners shall be provided, when indicated in the schedule on the drawings. Main valves shall regulate accurately throughout the range of pressure and flow conditions, and shall close on air failure. Acceptable Manufacturers: Copes Vulcan, Fisher Governor, Honeywell and Mason Neilan.
- B. Main Valve: Each valve shall have a cast iron body rated at 125 psi for inlet pressure of 100 psi or lower and 250 psi for inlet pressures in excess of 100 psi. Valves shall be either single or double seat plug type with linear or percentage flow characteristics. Valve trim shall be AISI Type 304 or 316 stainless steel, with top, bottom or cage guided plugs, renewable seats and guides, travel indicators and spring loaded teflon packing. Valve plugs for throttling service shall have a linear or percentage flow characteristic. Valves smaller than 2 inches may be screwed end type, with unions both sides of valve, and for sizes 2 inches and larger shall have flanged ends. Face to face body dimensions shall be as recommended by the Instrument Society of America (ISA RP4). Diaphragm actuators shall be full stroked when air to diaphragm is 3 to 15 or 6 to 30 psig, as required. Diaphragms shall be neoprene or Buna N with a nylon fabric insert.
- C. Control Pilot or Controller for each main valve shall measure variable and transmit a signal to main valve, and shall have range adjustments, proportional band and reset adjustments. Each control pilot or controller shall be enclosed in a dust proof cabinet and shall be yoke, wall or panel mounted as indicated, not more than 4 feet off floor or walkway for easy accessibility. Control pilot or controller shall be Fisher Wizard Type D 4150D or E 600 A.
- D. Valve Positioner: Assembly shall have travel adjustment, integral bypass valve and be complete with three air pressure gages. Positioners shall be provided when indicated on drawings and for following:
 - 1. Single ported valve with high pressure drop.
 - 2. Three way control valves.
 - 3. Main valve located a great distance from controller.
 - 4. Split service, i.e., two valves operating in sequence from a single controller.
- E. Primary Elements: Shall be provided when indicated on drawings and shall be as follows:
 - 1. For Pressure: Sensing device shall be a bourdon tube or bellows depending upon the pressure range.

2. For Temperature: Sensing device shall be a gas filled bulb type. Separable wells shall be provided when elements are installed in tanks or pipe lines.
 3. For Level Control: Sensing device shall be of displacement float meter type, mounted in an external cast iron housing.
 4. For Flow: Sensing device shall be an orifice plate, designed and installed in accordance with ASME Standards.
- F. Air Set: Each set shall consist of a filter-regulator to insure clean air positioners. Air sets shall be suitable for 150 psi inlet pressure with adjustable reduced range of 5 to 35 psig, complete with drip well.
- G. Sizing of Valves: Shall be in accordance with coefficients established by actual testing or in accordance with procedures laid down by the Instrument Society of America. Valve Cv coefficients shall be so stated on shop drawing submissions.
- H. Valve Usage: Pneumatically activated control valves shall be used for the following applications when so indicated on drawings:
1. Pressure Control (PCV): Pressure reducing, pressure relief, back pressure.
 2. Temperature Control (TCV): Domestic hot water heater control.
 3. Flow Control (FCV): Gas, oil.
 4. Level Control (LVC):

2.15 SAFETY AND RELIEF VALVES

- A. General Requirements: Valves shall be as specified by ASME Code governing manufacture of such valves within scope of their particular usage, i.e., Heating Boilers, Power Boilers, Unfired Pressure Vessels, etc., shall be tested, rated and listed by National Board of Boiler and Pressure Vessel Inspections and shall bear symbol of ASME and NBB and PVI, unless otherwise specified. Liquid relief valves do not require ASME tagging or marking, or NBB and PVI Certification. Valves for applications specified shall conform to the ASME Code, Section IV, Heating Boilers and the following:
1. Valves for Steam Heating Boilers: (Operating at 16 psig and above) shall be sized in accordance with ASME Boiler Code and the State of New York Department of Labor Code, shall be ASME Standard, ASME tested, and NBB & PVI certified and marked in accordance with ASME requirements. Valve body and yoke shall be cast steel ASTM A 216 Grade WCB and stem, disc, seat bushing or nozzle, adjusting ring, compression screw and other trim parts shall be stainless steel or equivalent material as approved by State. Valves shall have flanged inlet and outlet connections, with inlet connection being 300 lb. class.
 2. Valves for steam heating boilers operating at a maximum pressure of 15 psig shall have a maximum pressure setting of 15 psig. Sizing of valves shall be in accordance with ASME Table HG 400.1. Valve bodies shall be bronze or cast iron, with discs and seats of bronze.
 3. Valves for hot water heating boilers shall conform to the requirements of the ASME Code and have a maximum pressure setting of 30 psig. Valves shall be of Safety Relief type, i.e., shall lift slowly to relieve normal thermal pressure build-up and “pop” to relieve excessive pressure

- due to “runaway” conditions, caused by the failure of any pressure control device and shut-down firing mechanism on excessive pressure indication. Valve bodies shall be bronze or cast iron, with non-vulcanizing synthetic discs and with seats of bronze.
4. Valves for direct fired domestic hot water boilers shall conform to requirements of ASME Code, Section IV, Paragraph HG 400.2 (a). Valves shall be of temperature-pressure type, rated at 125 psig test pressure. Thermostatic element shall, on rising temperature, cause the valve to open at 188 degrees F. and valve shall deliver its rated capacity at 208 degrees F. and close drip tight at 183 degrees F. Valves for use on gas fired heaters shall be AGA approved and shall be so stamped or marked.
 5. Valves for combination domestic hot water heater and storage tanks shall conform to the requirements of ASME Code, Section IV and USA Standard Z21.22 and shall be NBB listed. Valves shall be of the temperature - pressure type. Thermostatic element shall, on rising temperature, cause the valve to open at 200 degrees F. and valve shall deliver its rated capacity at 210 degrees F. and close drip tight at 195 degrees F. Valves shall be sized in accordance with Unfired Vessel Code.
 6. Valves for Unfired Pressure Vessels: Safety and safety relief valves on secondary side of unfired pressure tanks, water heaters and heat exchangers shall comply with Code requirements governing applicable equipment as outlined in ASME Code, Section IV, Article 4, Paragraph HG 400.3 and as follows: Secondary side of heat exchanger shall be protected by officially rated valves, set for same pressure or temperature as heretofore specified, when secondary side furnishes steam or hot water for purpose equivalent to purposes for which a boiler would be installed; valves for this purpose shall be sized in accordance with Unfired Vessel Code.
 7. Relief Valves For Use On The Discharge Side of Steam Pressure Reducing Valve Stations:
 - a. When pressure reducing valve station is set to deliver steam at a pressure not to exceed 10 psig, safety relief valves shall comply with the requirements of the ASME Low Pressure Boiler Code, Section 4, Article 4 and shall be sized to relieve all steam that reducing valve or by-pass valve can deliver when in a wide-open position, without permitting pressure to rise above 20 psig.
 - b. When pressure reducing valve station is set to deliver steam at a pressure in excess of 10 psig, safety relief valves shall be manufactured in accordance with the ASME Power Code, Section 1, but may be sized in accordance with the Unfired Pressure Vessel Code. Valves shall relieve all steam the pressure reducing valve or by-pass valve can deliver, without permitting pressure to rise more than 10 percent above the maximum allowable working pressure.
 8. End Connections: Unless otherwise specified, safety valves, relief valves and safety relief valves, in sizes 3/4 inch to 3 inches IPS inclusive, may be furnished with male or female pipe thread inlet and female pipe thread outlet; valves over 3 inches IPS must be furnished with 125 lb. or

250 lb. flanged inlet and may be equipped with female threaded or 125 lb. flanged outlet.

2.16 NEEDLE STOP VALVES

- A. For Temperatures to 300 degrees F.: All brass or forged carbon steel construction, union bonnet, screwed ends, built for 1000 psi at 300 degrees F.
- B. For Temperature in Excess of 300 degrees F.: Carbon steel bar stock bodies, stainless steel stems, screwed ends, built for 4,500 psi at 450 degrees F.
- C. For Use In High Temperature Water Piping: Carbon steel bar stock or forged steel bodies, stainless steel stems, screwed ends, built for 4,500 psi at 450 degrees F.
- D. Acceptable Manufacturers: Marsh Instrument Company, Singer-American Meter Division, H.O. Trerice Co. and Weksler Instruments Corp.

2.17 GAGE COCKS

- A. Gage Cocks: All brass construction, "T" or lever handles, screwed ends, built for 300 psig hydraulic pressure. Acceptable Manufacturers: Marsh Instrument Company, Mueller Instruments Co., H.O. Trerice Co. and Weksler Instruments Corp.

2.18 GROOVED END VALVES

- A. Valves shall be of type, material and pressure rating, as required by the particular application, as approved.

2.19 VACUUM RELIEF VALVES

- A. For Use With Steam:
 - 1. Up to 15 psig: ITT Hoffman No. 62, and Watts Regulator Co. No. N36.
 - 2. 16 psig to 150 psig: ITT Hoffman No. 62.
- B. For Use With Water: Watts Regulator Co. No. N36.

2.20 BALL VALVES

- A. Type BV: 150 psig WSP, 600 psig WOG, 2 piece bronze body, solid blow-out proof stem, teflon seats, chrome plated brass ball, teflon seals, corrosion resistant steel lever handles with vinyl grips, balancing stop, and threaded or solder ends. Acceptable Manufacturers: Conbraco, Hammond, Milwaukee, Nibco, and Watts.

2.21 SELF CONTAINED THERMOSTATIC RADIATOR CONTROL VALVE

- A. Type: NPT Nickel-plated forged brass body with union outlet, EPDM disc, stainless steel spindle, replaceable insert, actuators capable of being changed without draining the system, valve mounted setting knob and remote temperature sensor (46 - 80 Degree F range), brass sensor with sensor guard, stainless steel

capillary tube, fully automatic- non electric, long term tested to 5000 cycles (1.3 Degree F).

1. Pressure Ratings:
 - a. Maximum Water Temperature: 250 degrees F.
 - b. Maximum Steam Pressure: 15 psig.
 - c. Max. Static Pressure: 145 psi
 - d. Max. Differential Pressure: 20 psi (Sized for 5 psi pressure drop at design flow)
2. Valve Coefficients (Cv):
 - a. 1/2 inch body size: 1.8
 - b. 3/4 inch body size: 2.5
 - c. 1 inch body size: 2.74
 - d. 1-1/4 inch body size: 5.0

- B. Acceptable Manufacturer: MACON CONTROLS, 118 Exchange Street, Chicopee, MA, 01013, (413) 594-8695.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: Install valves at locations noted on the drawings or specified.

3.02 MANUAL CONTROL VALVES FOR DIRECT RADIATION

- A. Provide manually operated valve for each cast iron radiator, convactor or finned type radiator. Do not install manually operated valves on any standing radiation, which is provided with an individual automatic temperature control valve.
- B. Steam Radiation Application:
1. Install globe, angle or straight-way type radiator valves for all steam fed cast iron radiators, convectors or finned type radiators. Where an angle or straight-way type valve cannot be used, install an offset body globe or offset corner pattern valve. Size valves in accordance with the following:
 - a. 1/2 inch for radiation 40 sq ft EDR and under.
 - b. 3/4 inch for 41 to 100 sq ft EDR.
 - c. 1 inch for 101 to 150 sq ft EDR.
- C. Hot Water Application:
1. Install globe, angle or straight-way type radiator valves for all hot water radiation. Where a regular globe or angle type valve cannot be used, install an offset body globe or offset corner pattern valve. Size valve full size of supply run out serving each heating unit.
 2. Install balancing fittings, full size of runouts, on all standing hot water radiation, whether or not provided with an automatic temperature control valve. Install balancing fittings in the returns only, of radiation installed in series.

3.03 STEAM PRESSURE REDUCING VALVE STATIONS

- A. When indicated on drawings, install one or more safety relief valves, on the “down-stream” or reduced pressure side of valve stations, at a point below the by-pass connection.
- B. Vents from Safety Relief Valves: Terminate vents outside building, unless otherwise indicated on drawings.

3.04 DISCHARGE PIPING FROM LIQUID RELIEF VALVES

- A. Connection vent piping to the discharge outlet of all relief valves and terminate over floor drain, bell outlet or other approved point of waste.

3.05 VALVE APPLICATION SCHEDULE

- A. Schedule of valve applications for the different services is as follows:
 - 1. Bearing Coolant (BWS & BWR) 125 psig and less:
 - a. 2 inches and less: Screwed end, D gates, 0 globe or angles and U checks.
 - b. 2-1/2 inches and Up: Flanged end, C gates or BF butterflies, C or K globe or angles and V checks.
 - 2. Boiler Blow-off (BO and CBD) 300 psig and less: Flanged end. Refer to specifications of blow-off valves in this section.
 - 3. Boiler Feed Pump Suction (BFS) 125 psig and less:
 - a. 2 inches and Less: Screwed end, A gates and J globe or angles.
 - b. 2-1/2 inches and Up: Flanged end, C gates and K globe or angles.
 - 4. Boiler Feed Pump Discharge (BFD) 126 to 250 psig:
 - a. 2 inches and Less: Screwed end, G gates, N globe or angles and CV-21 checks (except at boiler).
 - b. 2-1/2 inches and Up: Flanged end, F gates, M globe or angles and CV-21 checks (except at boiler).
 - 5. Boiler Feed at Boiler (BFD) 300 and less:
 - a. 1-1/2 inches and Less: Weld end, AV-8 globe or angles and CV-17 checks.
 - b. 2 inches and Up: Flanged end, AV-4 globe or angles and CV-4 checks.
 - 6. Boiler Trim, 300 psig and less, 2 inches and less: Screwed end, GV-7 gates and AV-7 globe or angles.
 - 7. Boiler Trim, Soot Blower, 300 psig and less, 2-1/2 inches and up: Flanged end, GV-4 gates and AV-4 globe or angles.
 - 8. Boiler Stop Check, 300 psig and less: Flanged end, SC-1 angles.
 - 9. Boiler Header Stop, 300 psig and less: Flanged end, AV-4 globe or angles.
 - 10. Boiler Feed Pump, Suction and Discharge (BFS & BFD), 125 psig and less:
 - a. 4 inches and Less: Screwed end, A gates, J globe or angles and S checks.
 - b. 5 inches and Up: Flanged end, C gates, K globe or angles and W or Z checks.

11. Chemical Feed at Boiler (CMF), 300 psig and less, 2 inches and less: Screwed end, GV-7 gates, AV-7 globe or angles and CV-19 checks.
12. Chemical Feed, at Chemical Tank and Pump (CMF), 300 psig and less, 2 inches and less: Screwed end, D gates, J globe or angles and X checks.
13. Chemical Feed (CMF) 125 psig and less:
 - a. 3 inches and Less: Screwed or solder ends, A or D gates, J or O globe or angles and S or U checks.
 - b. 5 inches and Up: Flanged end, C gates, K globe or angles and V checks.
14. Chilled Water (CWS & CWR) 125 psig and less:
 - a. 3 inches and Less: Screwed or solder ends, A or D gates or BV balls, J or O globe or angles and S or U checks.
 - b. 4 inches and Up: Flanged end, C gates or BF butterflies, K globe or angles and V checks.
15. Chilled Water (CWS & CWR) 126 to 250 psig: Flanged end, F or G gates or BF-HP butterflies, M globe or angles and X or Y checks.
16. Cold Water in Buildings and Tunnels (CW) 125 psig and less:
 - a. 3 inches and Less: Solder end, D gates or BV balls, O globe or angles and U checks, or flanged end, C gates, K globe or angles and V checks, with solder joint companion flanges.
 - b. 4 inches and Up: Flanged end, C gates or BF butterflies, K globe or angles and V checks.
17. Compressed Air (A) 125 psig and less:
 - a. 2 inches and Less: Screwed end, A gates, J globe or angles and W checks.
 - b. 2-1/2 inches and Up: Flanged end, C gates, K globe or angles and W checks.
18. Condensate Returns (LPR & MPR) 125 psig and less:
 - a. 4 inches and Less: Screwed end, A or C gates, J globe or angles and S checks.
 - b. 5 inches and Up: Flanged end, C gates, K globe or angles and V checks.
19. Condensate Returns (LPR & MPR) 125 psig and less:
 - a. 2 inches and Less: Screwed end, A gates, J globe or angles and S checks.
 - b. 2-1/2 inches and Up: Flanged end, C gates, K globe or angles and V checks.
20. Condenser Water (CF & CR) 125 psig and less:
 - a. 3 inches and Less: Screwed or solder ends, A or D gates or BV balls, J or O globe or angles and S or U checks.
 - b. 4 inches and Up: Flanged end, C gates or BF butterflies, K globe or angles and V checks.
21. Condenser Water (CF & CR) 126 to 250 psig: Flanged end, F or G gates or BF-HP butterflies, M globe or angles and X or Y checks.
22. Continuous Blow Down - Control Valve (CBD) 300 psig and less, 2 inches and less: Screwed end, B0-6 blow down valves.
23. Continuous Blow Down - Shut Off Valve (CBD) 300 psig and less, 2 inches and less: Screwed end, GV-7 gates and AV-7 globe or angles.
24. Domestic Hot Water and Circulating (DHW & DHWC):
 - a. 3 inches and Less: Solder end, D gates or BV balls, O globe or angles and U checks.

- b. 4 inches and Up: Flanged end, C gates or BF butterflies, K globe or angles and V checks.
- 25. Fuel Oil Fill (FOF) 125 psig and less, 2-1/2 inches and up: Flanged end, C gates, K globe or angles and V checks.
- 26. Fuel Oil Pump Suction (FPS) 125 psig and less:
 - a. 2 inches and Less: Screwed end, A gates, J globe or angles.
 - b. 2-1/2 inches and Up: Flanged end, C gates, K globe or angles.
- 27. Fuel Oil Pump Discharge (FPD) 126 to 250 psig:
 - a. 2 inches and Less: Screwed end, G gates, N globe or angles and X checks.
 - b. 2-1/2 inches and Up: Flanged end, F gates, M globe or angles and Y checks.
- 28. Fuel Oil Return (FOR) 125 psig and less:
 - a. 2 inches and Less: Screwed end, A gates, J globe or angles and S checks.
 - b. 2-1/2 inches and Up: Flanged end, C gates, K globe or angles and V checks.
- 29. Fuel Oil, No. 2 (FOS, FOR & FPD) 125 psig and less, 1 inch and less: Screwed end, A gates, J globes and S checks, with flared or ferrule copper tubing adapters.
- 30. Gas - Natural, Manufactured or Mixed Fuel (G) 125 psig and less:
 - a. 2 inches and Less: Screwed end, AB plug valves.
 - b. 2-1/2 inches and Up: Flanged end, AA plug valves.
- 31. Gas, Underground (G): Dresser end, AA plug valves.
- 32. Gas, Bottled Liquified Petroleum (BG): Screwed end, A gates and J globe or angles, with flared or ferrule copper tubing adapters.
- 33. High Temperature Water (HTS & HTR) 300 psig and less: Weld end, GV-8 gates, AV-8 globe or angles and CV-21 checks.
- 34. Hot Water (HWS & HWR) 125 psig and less:
 - a. 3 inches and Less: Screwed or solder ends, A or D gates or BV balls, J or O globe or angles and S or U checks.
 - b. 4 inches and Up: Flanged end, C gates or BF butterflies, K globe or angles and S checks.
- 35. Hot Water (HWS & HWR) 126 to 250 psig: Flanged end, F or G gates or BF-HP butterflies, M globe or angles and X or Y checks.
- 36. Instrument Air (IA) 60 psig and less, 1 inch and less: Screwed end, A gates and J globe or angles, with flared or ferrule copper tubing adapters.
- 37. Refrigerants R 12, R 22, and R 502 - Suction, Liquid and Hot Gas (RS, RL, HG, & RD) 350 psig and less, Up to 4-1/8 inches O.D.: Brazing end, RG globe and angles and RK or RL checks.
- 38. Refrigerants R 12, R 22, and R 502 - Purge, Drain and Charging (RS, RL, HG & RD) 350 psig and less, Up to 4-1/8 inches O.D.: Solder end, RH globe and angles.
- 39. Secondary Water (SWF & SWR) 125 psig and less:
 - a. 3 inches and Less: Screwed or solder ends, A or D gates or BV balls, J or O globe or angles and S and U checks.
 - b. 4 inches and Up: Flanged end, C gates or BF butterflies, K globe or angles and S checks.
- 40. Steam (LPS & MPS) 125 psig and less:
 - a. 4 inches and Less: Screwed end, A or C gates, J globe or angles and S checks.

- b. 5 inches and Up: Flanged end, C gates, K globe or angles and V checks.
- 41. Steam (HPS) 126 to 250 psig:
 - a. 2 inches and Less: Screwed end, G gates, N globe or angles and X checks.
 - b. 2-1/2 inches and Up: Flanged end, F gates, M globe or angles and Y checks.

END OF SECTION

SECTION 230529

PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Companion high density filler pieces for installation over the top 180 degree surface of pipe or tubing, at points of support where a combination clevis hanger, insulation shield and high density insulating saddle are installed.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Piping Insulation: Section 230700 or 230719.

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Details of trapeze hangers and upper hanger attachments for piping 2-1/2 inches in diameter and over. Include the number and size of pipe lines to be supported on each type of trapeze hanger.
 - 2. Details of pipe anchors.
 - 3. Details and method of installing restraints, anchors, and supports for grooved end piping systems
 - 4. Drawings identifying seismic locations with corresponding details of pre-approved seismic restraints, with seismic loads and seismic force level (Fp) calculations; pre-engineered and stamped by a NYS Licensed Professional Engineer experienced in seismic restraint systems.
- B. Product Data: Catalog sheets, specifications and installation instructions for each item specified except fasteners.
- C. Quality Control Submittals:
 - 1. Seismic Restraint Manufacturer's Qualifications Data:
 - a. Name of firm producing the seismic restraints, business address and telephone number.
 - b. Period of time firm has been in the business producing seismic restraints, and names and addresses of 3 similar projects that the manufacturer has produced seismic restraints for during the past 5 years.
 - 2. Company Field Advisor Data:
 - a. Name, business address and telephone number of Company Field Advisor secured for the required services.
 - b. Certified statement from the Company listing the qualifications of the Company Field Advisor.

- c. Services and each product for which authorization is given by the Company, listed specifically for this project.
3. Manufacturer's Certificate of Compliance for Seismic Restraints: Certificate from seismic restraint manufacturer stating that the restraint and its mounting system or anchorage has been tested or analyzed and meets the requirements of NYS Building Code (Section 1621).

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. Comply with the applicable requirements of the ASME B31 Piping Codes.
 2. Unless otherwise shown or specified, comply with the requirements of the Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS) Standards SP-58, and SP-69.
 3. The contractor shall provide pre-engineered or stamped and signed details (by a NYS Licensed Professional Engineer) of seismic restraint systems to meet total design lateral force requirements for support and restraint of mechanical and electrical systems.
 4. Seismic components shall be UL listed or California OSHPD (Office of Statewide Health Planning and Development) approved.
- B. Seismic Restraint Manufacturer Qualifications: The firm producing the seismic restraints shall be experienced in seismic restraint work and shall have produced seismic restraints for a minimum of 5 years.
- C. Company Field Advisor: Secure the services of a Company Field Advisor from seismic restraint manufacturer for the following:
 1. Render advice regarding installation and final adjustment of seismic restraint system.
 2. Render advice on the suitability of each seismic restraint for its particular application.
 3. Inspect completed installation of seismic restraint system and certify with an affidavit that the system is installed in accordance with the Contract Documents and is operating properly.
 4. Train facility maintenance personnel on the installation of seismic restraint system and routine maintenance of the system.

PART 2 PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

- A. Combination clevis hanger, pipe insulation shield and vapor barrier jacketed high density insulating saddle with companion high density filler piece.
 1. Insulating saddles and filler pieces shall be of the same thickness and materials as the adjoining pipe insulation. Saddles shall cover the lower 180 degrees of the pipe or tubing, and companion filler pieces shall cover the upper 180 degrees of the pipe or tubing. Physical sizes, gages, etc. of the components of insulated hangers shall be in accordance with the following schedule:

PIPE OR TUBING SIZE (Inches)	SHIELD LENGTH (Inches)	SHIELD GAGE	SADDLE LENGTH (Inches)	VAPOR BARRIER JACKET LENGTH (Inches)
Up to 2-1/2	4	16	6	10
3 to 6	4	14	6	10
8 to 14	10	12	12	16
16 and up	10	10	12	16

- B. Pipe Insulation Shields: Fabricated of steel, with a minimum arc of 180 degrees, unless otherwise indicated. Shields for use with hangers and supports, with the exception of combination clevis type hangers, shall be in accordance with the following schedule:

PIPE OR TUBING SIZE (Inches)	SHIELD LENGTH (Inches)	SHIELD GAGE
Up to 2-1/2	8	18
3 to 8	10	16
10 to 14	12	12
16 and up	18	10

- C. Pipe Covering Protection Saddles: 3/16 inch thick steel, of sufficient depth for the insulation thickness specified, notched so that saddle contact with the pipe is approximately 50 percent of the total axial cross section. Saddles for pipe 12 inches in size and larger shall have a center support.
- D. Pipe Hangers: Height adjustable standard duty clevis type, with cross bolt and nut.
1. Pipe spreaders or spacers shall be used on cross bolts of clevis hangers, when supporting piping 10 inches in size and larger.
- E. Adjustable Floor Rests and Base Flanges: Steel.
- F. Hanger Rods: Mild, low carbon 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.
- I. Restraints, Anchors, and Supports for Grooved End Piping Systems: As recommended by the grooved end fitting manufacturer, and as required for seismic restraints.

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 VIBRATION ISOLATION FOR PIPING

- A. Type: Combination rubber and spring type designed for insertion in a split hanger rod for isolating piping from the overhead construction.
 - 1. Approved isolators: Amber Booth Type BSSR, Korfund Type VX, Mason Industries, Type DNHS, Vibration Eliminator Co. Type SNRC and Vibration Mountings and Controls Type RSH.
- B. To ensure that piping weight is properly distributed and not being supported by equipment flanges, the first three rubber and spring isolators on the inlet shall be of the "position indicating" type.
 - 1. Approved Isolators: Amber Booth Type PBSS, Korfund Type VXLS, Mason Industries Type PDNHS, Vibration Eliminator Co. Type PR2H and Vibration Mountings and Controls Type RSHP.

2.04 SEISMIC RESTRAINT SYSTEM FOR PIPING

- A. General:
 - 1. Coordinate all structural attachments with the Director's Representative.

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 and as specified.
 5. Friction from gravity loads shall not be considered resistance to seismic forces.
 6. Construct seismic supports constructed so that support engagement is maintained.
 7. Stamp seismic supports with manufacturer's name and part number for identification.
 8. Design seismic supports specifically for mitigation of seismic force loads.
 9. Design the stiffness of seismic restraints for mechanical equipment so that the load path for the restraint performs its intended function.
 10. Where possible, utilize components designed with tamper resistant break-off bolt heads or break-off nuts to assure visual verification of proper installation.
 11. 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. Acceptable Manufacturers:
1. B-Line.
 2. Mason Industries.
 3. TOLCO Inc.
- D. Strut/Channel Bracing: 12 gauge solid 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 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.
1. Maximum Brace Length: 13 feet 1 inches.
- H. Rigid Seismic Braces For Trapeze Supported Pipe Systems: A12 strut channel or schedule 40 steel pipe.
1. 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: Medium carbon steel; size and type to suit application; galvanized for high humidity locations, and treated wood; plain finish for other interior locations. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work.

2.05 SHOP PAINTING AND PLATING

- A. Hangers, supports, rods, inserts and accessories used for pipe supports, unless chromium plated, cadmium plated or galvanized shall be shop coated with metal primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper pipe or copper tubing.
- B. Hanger supports for chromium plated pipe shall be chromium plated brass.

PART 3 EXECUTION

3.01 PREPARATORY WORK

- A. Place inserts into construction form work expeditiously, so as not to delay the Work.

3.02 INSTALLATION

- A. Do not hang or support one pipe from another or from ductwork.
 - 1. Do not bend threaded rod.

- B. Support all insulated horizontal piping conveying refrigerants or other 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, Alloy Steel, Threaded Brass Pipe and Fibrous Glass Reinforced Plastic Pipe (FRP):

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 Polypropylene pipe:

PIPE SIZE (Inches)	MAXIMUM SPACING (Feet)
1-1/2 and under	4
2 through 4	5
5 and over	6

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 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.
5. 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.
6. 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.
7. 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.

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" in size and smaller, installed in finished rooms or spaces other than mechanical equipment machine or steam service rooms, or penthouse mechanical equipment rooms.

F. Floor Supports: Install adjustable yoke rests with base flanges, for the support of piping, unless otherwise indicated on the Drawings. Install supports in a manner, which will not be detrimental to the building structure.

3.03 UPPER HANGER ATTACHMENTS

- A. General:
 - 1. Secure upper hanger attachments to overhead structural steel, steel bar joists, or other suitable structural members.
 - 2. Do not attach hangers to steel decks that are not to receive concrete fill.
 - 3. Do not attach hangers to precast concrete plank decks less than 2-3/4 inches thick.
 - 4. Do not use flat bars or bent rods as upper hanger attachments.
- B. Attachment to Steel Frame Construction: Provide intermediate structural steel members where required by pipe support spacing. Select steel members for use as intermediate supports based on a minimum safety factor of five.
 - 1. Do not use drive-on beam clamps.
 - 2. Do not support piping over 4 inches in size from steel bar joists. Secure upper hanger attachments to steel bar joists at panel points of joists.
 - 3. Do not drill holes in main structural steel members.
 - 4. Beam clamps, with tie rods as specified, may be used as upper hanger attachments for the support of piping, subject to clamp manufacturer's recommended limits.
- C. Attachment to Concrete Filled Steel Decks:
 - 1. New Construction: Install metal deck ceiling bolts.
 - 2. Existing Construction: Install welding studs (except at roof decks). Do not support a load in excess of 250 lbs from any single welded stud.
 - 3. Do not attach hangers to decks less than 2-1/2 inches thick.
- D. Attachment to Cast-In-Place Concrete: Secure to overhead construction by means of cast-in-place concrete inserts.
- E. Attachment to Existing Cast-In-Place Concrete:
 - 1. For piping up to a maximum of 4 inches in size, secure hangers to overhead construction with self-drilling type expansion shields and machine bolts.
 - 2. Secure hangers to wall or floor construction with single unit expansion shields or self-drilling type expansion shields and machine bolts.
- F. Attachment to Cored Precast Concrete Decks (Flexicore, Dox Plank, Spancrete, etc.): Toggle bolts may be installed in cells for the support of piping up to a maximum of 2-1/2 inches in size.
- G. Attachment to Hollow Block or Hollow Tile Filled Concrete Decks:
 - 1. New Construction: Omit block or tile and pour solid concrete with cast-in-place inserts.
 - 2. Existing Construction: Break out block or tile to access, and install machine bolt anchors at highest practical point on side of web.
- H. Attachment to Waffle Type Concrete Decks:
 - 1. New Construction: Install cast-in-place inserts.
 - 2. Existing Construction: Install machine bolt expansion anchors at highest practical point on side of web.

- I. Attachment to Precast Concrete Tee Construction:
 1. New Construction: Tee hanger inserts between adjacent flanges, except at roof deck without concrete fill.
 2. Existing Construction: Dual unit expansion shields in webs of tees. Install shields as high as possible in the webs.
 - a. Exercise extreme care in the field drilling of holes to avoid damage to reinforcing.
 - b. Do not use powder driven fasteners.

- J. Attachment to Wood Construction: Secure hangers to the sides (only) of wood members, by means of malleable iron side beam connectors, or malleable iron or steel side beam brackets. Do not secure hanger attachments to nailing strips resting on top of steel beams.
 1. Secure side beam connectors to wood members with two No. 18 x 1-1/2 inch long wood screws, or two No. 16 x 1-1/2 inch long drive screws. Do not support piping over 1-1/2 inches in size from side beam connectors. Do not hammer in wood screws.
 2. Secure side beam brackets to wood members with steel bolts or lag screws. Do not use lag screws in wooden members having a nominal thickness (beam face) under 2 inches in size. Install bolts or lag screws, in the sides of a timber or a joist, at the mid-point or above, not less than 2-1/2 inches from the lower edge when supporting branch lines and not less than 3 inches from the lower edge when supporting mains. Install heavy gage steel washers under all nuts.
 3. Secure side beam brackets to wooden beams or joists, with lag screws or bolts of size as follows:

PIPE SIZE (Inches)	LAG SCREW SIZE (Inches)	BOLT DIAMETER (Inches)
2 and under	3/8 diameter x 1-3/4	3/8
2-1/2 and 3	1/2 diameter x 2	1/2
4 and 5	Use Bolt	5/8

- a. Do not support piping larger than 3 inches with lag screws. Pre-drill holes for lag screws 1/8 inch in diameter less than the root diameter of the lag screw thread.
- b. The minimum width of the lower face of wood beams or joints in which lag screws of size as specified may be used is as follows:

LAG SCREW DIAMETER (Inches)	NOMINAL WIDTH OF BEAM FACE (Inches)
3/8	2
1/2	3

4. Do not secure hanger attachment to the diagonals or vertical members of the trusses.

3.04 ANCHORS, RESTRAINTS, RIGID SUPPORTS, STAYS AND SWAY BRACES

- A. Install pipe anchors, restraints and sway braces, at locations noted on the Drawings. 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. In grooved end piping systems, install restraints, and rigid supports as recommended by the manufacturer of the grooved end fittings to ensure proper support and alignment of the piping under operating and testing pressures (maximum hanger or support spacing shall be as previously specified).
 - 1. Horizontal piping shall maintain a constant pitch without sags, humps, or lateral deflections.
 - 2. Branch piping shall remain perpendicular to main piping and/or risers.
 - 3. Vertical piping shall remain plumb without deflections.
 - 4. Vertical piping shall be rigidly supported, or anchored at both top and bottom, and wherever necessary to prevent movement and/or shearing forces at branch connections.

3.05 PIPING IN TUNNELS (N/A)

- A. Support piping in tunnels on adjustable stanchions, fabricated in accordance with the details on the Drawings, unless otherwise indicated. Install, secure and be responsible for the proper locations of all cast-in-place inserts and stanchion supports, in ample time so as not to delay construction Work. Secure tops of stanchions to overhead construction, as required and approved.

3.06 COMBINATION CLEVIS HANGER, PIPE INSULATION SHIELD AND VAPOR BARRIER JACKETED HIGH DENSITY INSULATING SADDLES

- A. Install a combination clevis hanger, pipe insulation shield and vapor barrier jacketed high density insulating saddles, at all points of support for piping or tubing to be insulated for cold service. Furnish companion high density vapor barrier jacketed saddle pieces, of the same material, thickness and length, for installation over the top 180 degree surface of pipe or tubing, at each point of support where an insulated clevis hanger is utilized.

3.07 PIPE INSULATION SHIELDS

- A. Unless otherwise specified, install a pipe insulation shield, at all points of support. Center shields on all hangers and supports outside of high density insulation insert, and install in such a manner so as not to cut, or puncture jacket.

3.08 PIPE COVERING PROTECTION SADDLES

- A. Install pipe covering protection saddles at all points of support, for steel piping 6 inches in size and larger, insulated with hot service insulation. Weld saddles to piping to insure movement with pipe.

3.09 FIBROUS GLASS REINFORCED PLASTIC PIPE (FRP) SUPPORTS

- A. Provide inserts between supports and FRP as detailed.

3.10 VIBRATION ISOLATION FOR PIPING

- A. Install vibration isolation in accordance with the manufacturer's printed installation instructions, unless otherwise specified.
- B. Piping: The isolator deflections shall be equal to or greater than the static deflection of the vibration isolators provided for the connected machinery as follows:
 - 1. Piping Connected to Vibration Isolated HVAC Equipment: For a distance of 50 feet or 50 pipe diameters, whichever is greater.
 - 2. Condenser Water: For the full length of the piping.
 - 3. Chilled and Hot Temperature Piping: For risers from pumps and for the first 20 feet of the branch connection of the main supply and return piping at each floor.
 - 4. Water Distribution Piping Application: Resiliently support piping with combination rubber and spring isolation hangers.
 - a. Provide spring elements with 5/8-inch static deflection; install the hanger with spacing so that the first harmonic natural frequency is not less than 360 Hz. Provide double-deflection neoprene elements.
 - b. For the first two isolation hangers from the rotating equipment of 3-1/2 inch and smaller piping systems, ensure a deflection equal to the equipment-isolation static deflection.
 - c. For the first four piping isolation hanger supports from rotating equipment of 4-inch and larger piping systems, use resilient hanger-rod isolators at a fixed elevation regardless of load changes.
 - d. Incorporate an adjustable preloading device to transfer the load to the spring element within the hanger mounting after the piping system has been filled with water.
- C. Horizontal Piping Runs Within Mechanical Equipment, Steam Service, Machine and Penthouse Mechanical Equipment Rooms: Provide combination rubber and spring type isolators, designed for insertion of a split hanger rod, for the following :
 - 1. Chilled water supply and return;
 - 2. Condenser water supply and return;
 - 3. Heating hot water supply and return;
 - 4. Primary and secondary supply and return water;
 - 5. Steam and condensate piping.

3.11 SEISMIC RESTRAINT SYSTEMS FOR PIPING

- 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 loads to the Director's Representative.
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 Director's Representative if any 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 ft. 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 ft. maximum.
3. Provide longitudinal bracing at 80 ft. 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 ft. 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.
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

SECTION 230550

VIBRATION ISOLATION

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230529.

1.02 DEFINITIONS

- A. Ground Floor: Floor or floor slab of building resting directly on earth.

1.03 SUBMITTALS

- A. N/A
- B. Shop Drawings:
 - 1. Details of intermediate structural steel members and method of attachment required for installation of vibration isolating devices.
 - 2. Design Calculations: Calculations for selection of vibration isolators, design of vibration isolation bases, and selection of seismic restraints.
 - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
 - 4. Seismic Restraint Details: Detail fabrication and attachment of restraints and snubbers.
 - 5. Drawings identifying seismic locations with corresponding details of pre-approved seismic restraints, with seismic loads and seismic force level (Fp) calculations; pre-engineered and stamped by a NYS Licensed Professional Engineer experienced in seismic restraint systems.
- C. Product Data:
 - 1. Catalog sheets, specifications, and installation instructions.
 - 2. Vibration isolator schedule showing usage.
- D. Quality Control Submittals:
 - 1. Seismic Restraint Manufacturer's Qualifications Data:
 - a. Name of firm producing the seismic restraints, business address and telephone number.
 - b. Period of time firm has been in the business producing seismic restraints, and names and addresses of 3 similar projects that the manufacturer has produced seismic restraints for during the past 5 years.
 - 2. Company Field Advisor Data:
 - a. Name, business address and telephone number of Company Field Advisor secured for the required services.
 - b. Certified statement from the Company listing the qualifications of the Company Field Advisor.

- c. Services and each product for which authorization is given by the Company, listed specifically for this project.
3. Manufacturer's Certificate of Compliance for Seismic Restraints: Certificate from seismic restraint manufacturer stating that the restraint and its mounting system or anchorage has been tested or analyzed and meets the requirements of NYS Building Code (Section 1621).

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. Seismic components shall be UL listed or California OSHPD (Office of Statewide Health Planning and Development) approved.
- B. Seismic Restraint Manufacturer Qualifications: The firm producing the seismic restraints shall be experienced in seismic restraint work and shall have produced seismic restraints on minimum of 3 similar projects over the past 5 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS/COMPANIES

- A. Amber-Booth Co.
- B. Korfund Dynamics Corp.
- C. Mason Industries Inc.
- D. Vibration Eliminator Co., Inc.
- E. Vibration Mountings and Controls, Inc.

2.02 RUBBER-IN-SHEAR ISOLATORS

- A. Provide molded mound shaped rubber or neoprene elements designed to provide the required deflection under imposed load. Furnish isolators properly housed, with steel top plate and base plate completely imbedded in rubber or neoprene, for bolting to equipment and foundations, of type as follows:
 1. Single Rubber-In-Shear: Single element designed for static deflection of 1/4 inch.
 2. Double Rubber-In-Shear: Two single elements assembled in series, to provide for a static deflection of 1/2 inch.

2.03 STEEL SPRING ISOLATORS

- A. Types:
 1. Free Standing Springs: Provide laterally stable units, without housing, with a minimum 1/4 inch thick rubber or neoprene sound deadening pad between spring and its support. Use for isolating equipment having a static deflection in excess of 1 inch, unless otherwise indicated.

2. **Housed Springs:** Provide units with telescoping cast iron or steel housings, containing one or more springs, complete with resilient alignment inserts and a minimum 1/4 inch thick rubber or neoprene sound deadening pad bonded to the base of housing.
- B. **Construction Features Required:**
 1. Provide limit stops for spring isolators with deflections of 2 inch or more so as to prevent undue motion during start and stop, but unrestrained movement during normal operation.
 2. Hot dip galvanize all steel parts of isolators for outdoor use, with the exception of springs. Cadmium plate or neoprene coat springs.
 3. Do not use isolator leveling bolts for jacking screws.

2.04 INTEGRAL STRUCTURAL STEEL OR RAIL TYPE BASES

- A. Provide bases, factory fabricated from structural steel members of sufficient rigidity to maintain drive alignment and resist starting torque, without the use of restraining snubber devices. Provide bases complete with rubber-in-shear or spring type isolators, as specified for the particular equipment.

2.05 CONCRETE INERTIA BLOCKS

- A. **Type:** Factory fabricated welded structural steel pouring frames with the following:
 1. Sheet metal casing a minimum of 6 inches deep.
 2. Integral steel reinforcing rods on 9 inch centers in both directions, welded to steel frame;
 3. Height saving mounting lugs and spring isolators designed to provide the required deflection and efficiency.
- B. **Configure bases to accommodate supported equipment.**
 1. Provide bases for isolating pumps of physical size and shape as required to accommodate base elbow supports. Provide mounting templates.

2.06 VIBRATION ISOLATION BASES

- A. **Type:** Factory fabricated welded structural steel (ASTM A36) bases and rails with the following:
 1. Support brackets to anchor base to vibration isolation.
 2. Pre-located equipment anchor bolts.
 3. Auxiliary motor slide bases or rails.
 4. Steel angles welded to frame for outrigger isolation mountings.
 5. **Factory Finish:** Corrosive resistant finish.
- B. **Design bases to result in lowest possible mounting height with not less than one inch clearance above housekeeping pad or floor.**
- C. **Configure bases to accommodate supported equipment.**
 1. Provide bases for isolating pumps of physical size and shape as required to accommodate base elbow supports. Provide mounting templates.

2.07 COMBINATION RUBBER AND SPRING ISOLATORS

- A. Type: Combination rubber and spring type designed for insertion in a split hanger rod for isolating equipment from the overhead construction.
 - 1. Approved isolators: Amber Booth Type BSSR, Korfund Type VX, Mason Industries, Type DNHS, Vibration Eliminator Co. Type SNRC and Vibration Mountings and Controls Type RSH.

2.08 PAD TYPE ISOLATORS

- A. Provide neoprene or rubber mountings, corrugated or waffle faced both sides, single or double layered or laminated, or size and thickness as specified for the particular equipment.

2.09 SEISMIC RESTRAINT SYSTEM FOR HVAC EQUIPMENT

- A. General:
 - 1. Coordinate all structural attachments with the Director's Representative.
 - 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 and as specified.
 - 5. Determine by calculation the number and size of seismic restraints required by each piece of HVAC equipment.
 - 6. Construct seismic supports so that support engagement is maintained.
 - 7. Stamp seismic supports with manufacturer's name and part number for identification.
 - 8. Design seismic supports specifically for mitigation of seismic force loads.
 - 9. Design the stiffness of seismic restraints for mechanical equipment so that the load path for the restraint performs its intended function.
 - 10. Where possible, utilize components designed with tamper resistant break-off bolt heads or break-off nuts to assure visual verification of proper installation.
 - 11. Attachment components shall be UL Listed catalog components with published loads designed specifically for seismic application.
 - 12. Seismic restraint manufacturer shall have ratings verified by independent testing laboratory.
- B. Type: Pre-engineered seismic restraint system designed to support and restrain HVAC equipment to meet applicable lateral force requirements.
- C. Acceptable Manufacturers:
 - 1. B-Line.
 - 2. Mason Industries.
 - 3. TOLCO Inc.

- D. Thrust Restraints: Combination spring and elastomeric restraints with coil spring and elastomeric insert in compression, factory set for thrust.
 - 1. Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
 - 4. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 5. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.
- E. Manufactured Seismic Snubbers: All-directional, double-acting snubbers.
 - 1. Construction: Interlocking steel members restrained by 3/4 inch thick, replaceable, shock-absorbing neoprene insert. Maintain 1/8 inch clearance in all directions between rigid and resilient surfaces.
- F. Fabricated Seismic Snubbers: Welded structural-steel shapes designed and fabricated to restrain equipment or vibration isolation bases from excessive movement during seismic event. Design laterally restrained isolators to resist gravity forces of 4g.
 - 1. Construction: Welded steel shapes conforming to ASTM A36.
 - 2. Resilient Components: 3/4 inch thick, replaceable, shock-absorbing neoprene insert.
- G. Restrained Spring Mountings: Spring isolators with ductile iron or steel rigid housings with the following:
 - 1. Molded neoprene cup or 1/4 inch neoprene acoustical friction pad between base plate and support.
 - 2. Leveling bolts which are rigidly bolted to equipment.
 - 3. Restraining bolts with neoprene bushing between bolt and housing.
 - 4. Vertical Limit Stops: Prevent spring extension when weight is removed; out of contact during normal operation.
 - 5. Internal isolation pad required where housings are bolted or welded into position.
 - 6. Minimum Clearance Around Restraining Bolts and Between Housing and Spring: 1/2 inch.
 - 7. Vertically adjustable allowing maximum of 1/4 inch travel in all directions before contacting resilient snubbing collars.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Jack equipment bases or inertia bases into position and block or wedge before springs are loaded. After equipment is bolted in place and springs are loaded, by means of the leveling bolts, remove the temporary blocking or wedging.
- B. Housekeeping Pads:

1. Coordinate size and location of pads with the Work of related contracts.
 2. Coordinate house keeping pads with restraint manufacturer to provide minimum edge distance of 10 bolt diameters around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings.
 - a. If cast-in anchors are being used, size housekeeping pads in accordance with ACI requirements for bolt coverage and embedment.
- C. Vibration Isolation Bases:
1. Coordinate size and location of bases with the Work of related contracts.

3.02 APPLICATION

- A. Provide vibration isolators or vibration isolation bases for mechanical equipment, piping and high velocity ductwork of type as specified.
- B. Select isolation devices for uniform static deflection, in accordance with the distribution of weight and forces.
1. Whenever rotational speed is the cause of disturbing frequency, utilize the lowest operating speed of the equipment in determining the type of isolation required.
 2. Selection shall result in uniform loading and deflection, even when equipment weight is not evenly distributed.
 3. Select springs for a total deflection greater than the selected static deflection, to provide an adequate safety factor.
- C. Isolate floor mounted fan units, air handling units and self-contained air conditioning units, (with the exception of utility sets, fan units with wheels less than 27 inches and all equipment mounted on the ground floor), to obtain the following efficiencies:

RPM	MINIMUM DEFLECTION	EFFICIENCY
Up to 325	3.5	80
326 to 525	2.0	80-90*
526 to 575	1.5	90
576 to 1000	1.25	90-95*
1001 to 1200	.75	95
1201 and over	.50	95

*Lower efficiency at lowest RPM - higher efficiency at highest RPM.

3.03 VIBRATION ISOLATION SCHEDULE

- A. Fans and Air Handling Units:
1. Equip fans and air handling units, located above the ground floor and not indicated to be provided with a concrete inertia block or be ceiling mounted or suspended with vibration elimination equipment as follows:
 - a. Provide an integral structural steel base with a common steel member running the full length of the fan and motor, with built-

- in motor slide rails, so as to form a common support for fan unit and motor, with spring type isolators, unless otherwise indicated.
 - b. Provide spring unit isolators, or steel rail type isolator bases with spring type isolators, for floor mounted units with motors mounted on the casings or frames.
 - 2. Equip fans and handling units located on the ground floor, with the exception of medium or high pressure units not specified to be provided with a concrete inertia block, or be ceiling mounted or suspended, with unit isolators or steel rail type isolator bases.
 - 3. Floor Mounted Utility Fan Sets:
 - a. Provide unit isolators or steel rail type isolator bases.
 - b. Utility Sets with Overhung Scrolls: Provide steel rail type isolator bases, with built-in reaction units to compensate for overhang.
 - 4. Concrete Inertia Blocks for Fans and Air-Handling Units:
 - a. Provide inertia blocks, 1-1/2 times the weight of supported equipment, motor and drive for the following:
 - 1) Fans and air handling units, operating at a static pressure up to 5 inches w.g., driven by electric motor 30 to 100 HP inclusive, or having wheel diameters 45 to 100 inches inclusive.
 - 2) Fans and air handling units, operating at a static pressure of 5 inches w.g. or more, driven by motors 30 to 60 HP inclusive.
 - b. Provide inertia blocks, 2 times the weight of supported equipment, motor and drive for the following:
 - 1) Fans and air handling units, operating at a static pressure up to 5 inches w.g., driven by motors over 100 HP.
 - 2) Fans and air handling units, operating at a static pressure of 5 inches w.g. or more, driven by motors 75 HP and larger.
 - 5. Ceiling Suspended Fans and Air Handling Units: Provide combination rubber and spring type isolators, designed for insertion in a split hanger rod. Provide isolators with an efficiency as specified under the paragraph entitled "APPLICATION" of this Section, with no deflection greater than 1-1/2 inches required.
- B. Pumps - Base Mounted and Unitary Types:
 - 1. Located Above the Ground Floor:
 - a. Driven by Electric Motors 5 to 15 HP: Provide structural steel rails, running full length of bed plate, with housed type spring isolators, and in the case of close coupled pumps, rails shall extend full length under and over hang so as to compensate for the cantilever effect. Provide isolators designed for a minimum 1/2 inch static deflection.
 - b. Driven by Electric Motors 20 to 40 HP: Provide inertia blocks, minimum of 1-1/2 times the weight of equipment.
 - c. Driven by Electric Motors 50 HP and Larger: Provide inertia blocks, minimum of 2 times the weight of equipment.

- C. Centrifugal Compressors, Evaporative Condensers and Packaged Cooling Towers: Provide housed spring type isolators, complete with vertical resilient limit stops, so as to prevent spring extension when equipment is unloaded. Approved isolators: Amber Booth Type CT, Korfund Type WSCL, Mason Industries Type SLR, Vibration Eliminator Type FRS, Vibration Mountings Type, designed for a minimum 3/4 inch static deflection.
- D. Direct Connected Reciprocating Compressors and Packaged Chillers: Provide spring unit isolators or steel rail type isolator bases with spring isolators. Spring isolators: Complete with vertical hold down feature to limit upward travel, when equipment is unloaded.
- E. Absorption Machines: Provide 1/2 inch thick rubber or neoprene pads.
- F. Remote Installed Refrigerant Compressor Units, Self Contained Belt Driven or Direct Driven Condensing Units and Floor Mounted Product Coolers: Provide steel rail type bases with built-in, metal housed, rubber-in-shear unit isolators, permanently fixed in place and provided with adjustable snubber devices. Provide rail bases on Ground Floor designed for 1/4 inch static deflection and above Ground Floor 1/2 inch static deflection.
- G. Ceiling Suspended Product Coolers: Provide combination rubber and spring type isolators, designed for insertion in a split hanger rod. Provide isolators with an efficiency as specified under the paragraph entitled "APPLICATION" of this section, with no deflection greater than 1-1/2 inch required.

3.04 SEISMIC RESTRAINT SYSTEM FOR HVAC EQUIPMENT

- A. General:
 - 1. Do not use powder-actuated fasteners for seismic restraint anchorage in tension applications.
 - 2. Install seismic restraints in accordance with seismic restraint manufacturer's printed installation instructions and guidelines unless otherwise specified.
 - 3. 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 duct, equipment or support connections.
 - 4. Do not brace seismic bracing to different parts of the building that may respond differently during seismic activity.
 - 5. Provide adequately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire stopping in fire-rated walls.
 - 6. Seismic restraint installations shall not cause any modifications in the positioning of equipment or piping resulting in stresses or misalignment.
 - 7. 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.
 - 8. Bracing attached to structural members may present additional stresses. Submit loads to the Director's Representative record for approval.

9. Provide vertical stiffening components to support rods when necessary to accept compressive loads. Welding of components to vertical support rods is not acceptable.
 10. Notify Director's Representative if any discrepancies between the specifications and field conditions prior to installation.
- B. Seismic Restraints for HVAC Equipment:
1. Protect each piece of vibration isolated HVAC equipment with protected spring isolators or separate seismic restraints.
 - a. Provide protected spring isolators and seismic restraints rated in 3 principle axes.
 2. Installation of seismic restraints shall not cause any change in position of equipment or piping, resulting in stresses or misalignment.
 3. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.
 4. Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building unless isolation is not specified.
 5. Prior to installation, bring to the Director's Representative's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.
 6. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Bracing attached to structural members may present additional stresses. Submit loads to the Director's Representative.
 7. Expansion anchors shall not be used for non-vibration isolated equipment rated over 10 HP.
- C. Anchor interior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural floors.
- D. Anchor exterior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural supports as required.
- E. Vertical Stops: For equipment affected by wind pressure or having an operational weight different from installed weight, provide resilient vertical limit stops that prevent spring extension when weight is removed.
1. Provide vertical stops for equipment containing liquid, such as water chillers, evaporative coolers, boilers, and cooling towers.
 2. Spring isolated or protected spring isolated equipment must rock and move freely within limits of stops or seismic restraint devices.
- F. Thrust Restraints: Where required, provide pairs of thrust restraints, symmetrically installed on both sides of the steady state line of thrust.
- G. Seismic Snubbers: Provide snubbers as close as possible to each vibration isolator as indicated. After installing and leveling of the equipment, adjust snubbers in accordance with the snubber manufacturer's instructions.
- H. Equipment: Provide vibration isolators, flexible connectors and seismic snubbers in accordance with manufacturer's recommendations. Equipment with spring

isolators or protected spring isolators shall rock or move freely within limits of stops or seismic snubber restraints.

- I. Stability: Isolators shall be stable during starting and stopping of equipment without traverse and eccentric movement of machinery that would damage or adversely affect the equipment or attachments.
- J. Lateral Motion: The installed vibration isolation system for each piece of floor or ceiling mounted equipment shall have a maximum lateral motion under machinery start up and shut down conditions of not more than 1/4 inch. Restrain motions in excess by approved spring mountings.
- K. Unbalanced Equipment : Provide foundation suspension systems specifically designed to resist horizontal forces for equipment with large unbalanced horizontal forces. Vibration isolator systems shall conform to the equipment manufacturer's recommendations.
- L. Non-rotating Equipment: Mount non-rotating equipment in systems which includes rotating or vibrating equipment on isolators having the same deflection as the hangers and supports for the pipe connected to.
- M. Install flexible pipe connectors at connections for equipment supported on vibration isolators.
- N. Equipment Room Sound Isolation: Do not allow direct contact between pipe or ducts and walls, floor slabs, roofs, ceilings or partitions of equipment rooms.

3.03 FIELD QUALITY CONTROL

- A. Provide equipment and apparatus required for performing inspections and tests.
 - 1. Notify Director's Representative a minimum of 14 days prior to equipment sound, vibration, and seismic testing.
 - 2. Rebalance, adjust, or replace equipment with noise or vibration levels in excess of those given in the equipment specifications, or equipment manufacturer's data.
- B. Field Inspections:
 - 1. Prior to initial operation, inspect the vibration isolators and seismic snubbers for conformance to drawings, specifications, and manufacturer's data and instructions.
 - a. Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls.
 - b. Check connector alignment before and after filling of system and during operation.
 - c. Correct misalignment without damage to connector and in accordance with manufacturer's recommendations.
- C. Spring Isolator Inspection
 - 1. After installation of spring isolators or protected spring isolators, and seismic restraint devices, the equipment shall rock freely on its spring

isolators within limits of stops or seismic restraint devices. Eliminate or correct any interferences.

D. Tests

1. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.
2. Equipment Vibration Tests
 - a. Perform vibration tests to determine conformance with vibration isolation schedule specified.

END OF SECTION

SECTION 230553

PIPE AND VALVE IDENTIFICATION

PART 1 GENERAL

1.01 REFERENCES

- A. ANSI A13.1 - Scheme for Identification of Piping Systems.

1.02 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions for each item specified.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. W.H. Brady Co., Milwaukee, WI.
- B. Emed Co., Buffalo, NY.
- C. Panduit Corp., Tinley Park, IL.
- D. Seton Nameplate Corp., New Haven, CT.

2.02 PIPE MARKERS AND ACCESSORIES

- A. Snap-on Marker: One piece wrap around type constructed of precoiled acrylic plastic with clear polyester coating, integral flow arrows, legend printed in alternating directions, 3/4 inch adhesive strip on inside edge, and 360 degree visibility.
- B. Strap-On Marker: Strip type constructed of precoiled acrylic plastic with clear polyester coating, integral flow arrows, legend printed in alternating directions, factory applied grommets, and pair of stainless steel spring fasteners.
- C. Stick-On Marker: Pressure sensitive adhesive backed type constructed of vinyl with clear polyester coating, and integral flow arrows for applications where flow arrow banding tape is not being used.
- D. Pipe Marker Legend and Color Field Sizes:

OUTSIDE DIAMETER OF PIPE OR INSULATION (Inches)	LETTER SIZE (Inches)	LENGTH OF COLOR FIELD (Inches)
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OUTSIDE DIAMETER OF PIPE OR INSULATION (Inches)	LETTER SIZE (Inches)	LENGTH OF COLOR FIELD (Inches)
3/4 to 1-1/4	1/2	8
1-1/2 to 2	3/4	8
2-1/2 to 6	1-1/4	12
8 to 10	2-1/2	24
Over 10	3-1/2	32

- E. Banding Tapes: Pressure sensitive adhesive backed type constructed of vinyl with clear polyester coating.
 - 1. Plain Tape: Unprinted type; color to match pipe marker background.
 - 2. Flow Arrow Tape: Printed type with integral flow arrows; color to match pipe marker background.
- F. Pipe Size Labels: Pressure sensitive adhesive backed type constructed of vinyl with clear polyester coating, vertical reading pipe size in inches, and legend size matching adjacent pipe marker.

2.03 PIPE SERVICE IDENTIFICATION TAGS

- A. Type: No. 19 B & S gage brass, with 1/4 inch high pipe service abbreviated legend on one line, over 1/2 inch high pipe size legend in inches, both deep stamped and black filled; and 3/16 inch top hole for fastener.
- B. Size: 2 inch square tag.
- C. Fasteners: Brass "S" hook or brass jack chain of size as required for pipe to which tag is attached.

2.04 VALVE SERVICE IDENTIFICATION TAGS

- A. Type: No. 19 B & S gage brass, with 1/4 inch high valve service abbreviated lettering on one line over 1/2 inch high valve service chart number, both deep stamped and black filled; and with 3/16 inch top hole for fastener.
- B. Sizes:
 - 1. HVAC Use: 1-1/2 inch dia round.
- C. Fasteners: Brass "S" hook or brass jack chain of size as required for valve stem or handle to which tag is attached.

2.05 VALVE SERVICE IDENTIFICATION CHART FRAMES

- A. Type: Satin finished extruded aluminum frame with rigid clear plastic glazing, size to fit 8-1/2 x 11 inches valve chart.

PART 3 EXECUTION

3.01 PREPARATION

- A. Complete testing, insulation and finish painting work prior to completing the Work of this Section.
- B. Clean pipe surfaces with cleaning solvents prior to installing piping identification.
- C. Remove dust from insulation surfaces with clean cloths prior to installing piping identification.

3.02 INSTALLATION

- A. Install the Work of this Section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.
- B. Stick-On Pipe Markers:
 - 1. Install minimum of 2 markers at each specified location, 90 degrees apart on visible side of pipe.
 - 2. Encircle ends of pipe markers around pipe or insulation with banding tape with one inch lap. Use plain banding tape on markers with integral flow arrows, and flow arrow banding tape on markers without integral flow arrows.
- C. Pipe Size Labels: Install labels adjacent to each pipe marker and upstream from flow arrow. Install a minimum of 2 pipe size labels at each specified location, 90 degrees apart on visible side of pipe.
- D. Pipe Service Identification Tags: Attach tags to piping being identified with "S" hooks or jack chains.

3.03 PIPING IDENTIFICATION SCHEDULE

- A. Piping Identification Types:
 - 1. Piping or Insulation under 3/4 inch od: Pipe identification tags.
 - 2. Piping or Insulation 3/4 inch to 5-7/8 inch od: Snap-on marker or stick-on marker.
 - 3. Piping or Insulation 6 inch od and Larger: Strap-on marker or stick-on marker.
- B. Identify exposed piping, bare or insulated, as to content, size of pipe and direction of flow, with the following exceptions:
 - 1. Piping in non-walk-in tunnels or underground conduits between manholes.
 - 2. Piping in furred spaces or suspended ceilings, except at valve access panels where valves and piping shall be identified as specified for exposed piping systems.
 - 3. Piping in finished spaces such as offices, class rooms, wards, toilet rooms, shower rooms and spaces as specified.

- C. Locate piping identification to be visible from exposed points of observation.
 - 1. Locate piping identification at valve locations; at points where piping enters and leaves a partition, wall, floor or ceiling, and at intervals of 20 feet on straight runs.
 - 2. Where 2 or more pipes run in parallel, place printed legend and other markers in same relative location.

3.04 VALVE IDENTIFICATION SCHEDULE

- A. Valve Service Identification Tags:
 - 1. Tag control valves, except valves at equipment, with a brass tag fastened to the valve handle or stem, marked to indicate service and numbered in sequence for the following applications:
 - a. Domestic water valves controlling mains, risers and branch runouts.
 - b. Gas valves controlling mains, risers, and branch runouts.
 - c. Valves in heating, ventilating, air conditioning and refrigeration systems.
- B. Valve Service Identification Charts:
 - 1. Provide 2 framed valve charts for each piping system specified to be provided with valve identification tags. Type charts on 8-1/2 x 11 inches heavy white bond paper, indicating valve number, service and location.
 - 2. Hang framed charts at locations as directed.

END OF SECTION

SECTION 230554

DUCT AND EQUIPMENT IDENTIFICATION

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. N/A

1.02 DELIVERY, STORAGE AND HANDLING

- A. Deliver paint to the Site in original, new unopened containers, bearing manufacturers' printed labels.
- B. Store materials at the site where directed. Keep storage space clean and accessible to the Director's Representative at all times.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Paint: Type IAL-3.

PART 3 EXECUTION

3.01 PREPARATION

- A. Protection: Cover and protect surfaces to be painted, adjacent surfaces not to be painted, and removed furnishings and equipment from existing paint removals, airborne sanding particles, cleaning fluids and paint spills using suitable drop cloths, barriers and other protective devices.
 - 1. Schedule and coordinate surface preparations so as not to interfere with work of other trades or allow airborne sanding dust particle to fall on freshly painted surfaces. Do not perform the Work of this Section until testing, insulation and finish painting Work have been completed.
 - 2. Provide adequate natural or mechanical ventilation to allow surfaces to be prepared and painted in accordance with product manufacturer's instructions and applicable regulations.
 - 3. Provide and maintain "Wet Paint" signs, temporary barriers and other protective devices necessary to protect prepared and freshly painted surfaces from damages until Work has been accepted.
- B. Clean and prepare surfaces to be painted in accordance with specifications, paint manufacturer's approved product data sheets and printed label instructions. In the event of conflicting instructions or directions, the more stringent requirements shall apply.

1. Cleaners: Use only approved products manufactured or recommended by finish paint manufacturer. Unless otherwise recommended by cleaner manufacturer, thoroughly rinse with clean water to remove surface contaminants and cleaner residue.

3.02 DUCT IDENTIFICATION

- A. Identify exposed ductwork, bare or insulated, directly connected to air handling apparatus, in the following spaces or rooms, by means of painted stenciled legends:
 1. Mechanical Equipment.
 2. Steam Service.
 3. Refrigeration Machine.
 4. Boiler.
 5. Penthouse.
 6. Power House.
- B. Locate stenciled legends to be readily visible from any point of observation. Stencil identification along center line of duct, close to equipment. Where view is unobstructed from two directions, apply two sets of stenciling (both sides), visible from each direction.
- C. Letter Size: 1-1/2 inches in height.
- D. Samples of Ductwork Identification:
 1. Fresh Air Supply.
 2. Air Cond. Supply Air.
 3. Air Cond. Return Air.
 4. Recirc. Cond. Air.
 5. Exhaust Air.
- E. Colors: Paint stenciled letters black. Where the background color is dark, paint background white before stenciling.

3.03 EQUIPMENT IDENTIFICATION

- A. Identify mechanical equipment, bare or insulated, installed in the following spaces or rooms, by means of painted stenciled legends:
 1. Mechanical Equipment.
 2. Steam Service.
 3. Refrigeration Machine.
 4. Boiler.
 5. Penthouse.
 6. Power House.
- B. Paint stenciled legends black, a minimum of 1-1/2 inches in height, located to be readily visible from a reasonable point of view. Place identification along center line of equipment, if possible.
- C. Samples of Equipment Identification:
 1. Air Cond. Unit AC 1.

2. Supply Fan S 1.
3. Exhaust Fan E 1.
4. Return Fan R 1.

3.04 APPLICATION OF PAINT

- A. Stencil Painting: Apply with a brush or aerosol type spray can.

3.05 CLEANING

- A. Clean adjacent surfaces of paint spatters resulting from the Work of this Section.

END OF SECTION

SECTION 230593

CLEANING AND TESTING (As applicable)

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Balancing of Systems: Section 230594.

1.02 SUBMITTALS

- A. Quality Control Submittals
 - 1. Test Reports (Field Tests):
 - a. Refrigeration Systems: Submit test results on Refrigeration Systems Pressure - Dehydration Tests, Form BDC-228, a sample of which can be obtained from the Director's Representative, or a similar test report form, which includes the data shown on Form BDC-228.
 - b. Low Pressure Steam or Hot Water Heating Boilers: Submit test results on Boiler Test Record, Form BDC-360, a sample of which can be obtained from the Director's Representative, or a similar test report form, which includes the data shown on Form BDC-360.
 - c. Propylene Glycol System Test: Submit test results in a format acceptable to the Director's Representative.
 - d. Submit data for each system tested, and/or disinfected; include date performed, description, and test results for each system.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Perform factory testing of factory fabricated equipment in complete accordance with the agencies having jurisdiction.
 - 2. Perform field testing of piping systems in complete accordance with the local utilities and other agencies having jurisdiction and as specified.

1.04 PROJECT CONDITIONS

- A. Protection: During test Work, protect controls, gages and accessories which are not designed to withstand test pressures. Do not utilize permanently installed gages for field testing of systems.

1.05 SEQUENCING AND SCHEDULING

- A. Transmit written notification of proposed date and time of operational tests to the Director's Representative at least 5 days in advance of such tests.

- B. Perform cleaning and testing Work in the presence of the Director's Representative.
- C. Pressure test piping systems inside buildings, at the roughing-in stage of installation, before piping is enclosed by construction Work, and at other times as directed. Perform test operations in sections as required and directed, to progress the Work in a satisfactory manner and not delay the general construction of the building. Valve or cap-off sections of piping to be tested, utilizing valves required to be installed in the permanent piping systems, or temporary valves or caps as required to perform the Work.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Test Equipment and Instruments: Type and kind as required for the particular system under test.
- B. Test Media (air, gas, refrigerant, dry nitrogen, vacuum, water): As specified for the particular piping or system under test.
- C. Cleaning Agent (chemical solution, steam, water): As specified for the particular piping, apparatus or system being cleaned.
- D. Propylene Glycol: Permanent type anti-freeze solution as manufactured by Dow Chemical Co. or Union Carbide.
 - 1. Percentage of Propylene Glycol: 40% percent.

PART 3 EXECUTION

3.01 PRELIMINARY WORK

- A. Thoroughly clean pipe and tubing prior to installation. During installation, prevent foreign matter from entering systems. Prevent if possible and remove stoppages or obstructions from piping and systems.
- B. Thoroughly clean compressed air, control air, refrigerant pipe and similar systems prior to pressure or vacuum testing.
 - 1. Refrigerant Piping:
 - a. Only use factory sealed refrigerant piping.
 - b. Crimp and braze caps on ends of previously cleaned piping at end of the day if piping was cut.
 - c. When brazing, purge lines with dry nitrogen.

3.02 PRESSURE TESTING OF PIPING

- A. Piping shall be tight under test and shall not show loss in pressure or visible leaks, during test operations or after the minimum duration of time as specified.

Remove piping which is not tight under test; remake joints and repeat test until no leaks occur.

B. General:

1. Pressure test piping systems inside buildings, at the roughing-in stage of installation, before piping is enclosed by construction Work, and at other times as directed.
2. Perform test operations in sections as required and directed, to progress the Work in a satisfactory manner and not delay the general construction of the building.
3. Valve or cap-off sections of piping to be tested, utilizing valves required to be installed in the permanent piping systems, or temporary valves or caps as required to perform the Work.
4. Isolate existing piping from pressure testing.
5. Pressure test only new piping unless otherwise specified or directed by Director's Representative.

C. Water Systems:

1. Domestic water (potable cold, domestic hot and recirculation) inside buildings:
 - a. Before fixtures, faucets, trim and accessories are connected, perform hydrostatic test at 125 psig minimum for 1 hours.
 - b. After fixtures, faucets, trim and accessories are connected, perform hydrostatic retest at 75 psig for 4 hours.
2. Circulating water systems, including propylene glycol solution systems and cold water make-up piping connections to heating, ventilating, air conditioning and refrigeration systems, unless otherwise specified:
 - a. Before final connections are made perform hydrostatic test at 1-1/2 times the maximum working pressure, but not less than 125 psig, for 1 hours.
 - b. After final connections are made perform hydrostatic retest at a pressure equal to maximum operating system design pressure, but not less than 60 psig, for 4 hours.
3. High temperature water systems (supply and return):
 - a. Before final connections are made perform hydrostatic test at 450 psig for 4 hours.
 - b. After final connections are made perform hydrostatic retest at a pressure equal to maximum operating design pressure, but not less than 250 psig for 4 hours.

D. Steam, Condensate Return and Pump Discharge Piping: Before final connections are made perform hydrostatic test at 1-1/2 times maximum working pressure, but not less than 150 psig for one hour.

E. Gas Piping: Before backfilling or concealment perform air test of duration and pressure as required by the local gas company. However, for gas piping designed for pressures of from 4 inches to 6 inches water column, air test at 15 inches Hg for one hour, without drop in pressure. Test gas piping with air only. Check joints for leaks with soap suds.

F. Air Piping:

1. Compressed Air: Test with air at 150 psig for one hour.
 2. Control Air: Test with air at 50 psig for one hour.
 3. Check joints for leaks with soap suds.
- G. Vacuum Piping: Perform air test at 150 psig for one hour, followed by a vacuum test of 25 inches Hg for one hour, during which time the mercury shall remain stationary for the last 30 minutes of test.
- H. Fuel Oil Piping (Suction and Return): Perform air test at 150 psig for one hour, followed by a vacuum test of 25 inches Hg for one hour, during which time the mercury shall remain stationary for the last 30 minutes of test.
- I. Gasoline Piping: As Specified under the Section entitled "Fuel Dispensing System".

3.03 PRESSURE TESTING OF POWER HOUSE PIPING

- A. Hydrostatically test all non boiler external piping in accordance with Paragraph 137 of the ASME B31.1 Power Piping Code.
- B. General:
1. Provide temporary equipment for testing, including pump and gages.
 2. Test gage shall be accurate to within 3 psig and shall be calibrated within six months of the test as recorded on a sticker on the gage.
 3. Test piping system before insulation is installed.
 4. Perform pressure testing following the completion of postweld heat treatment, nondestructive examinations, and all other fabrication, assembly, and erection activities required to provide the system or portions thereof subjected to the pressure test with pressure retaining capability.
 5. Remove control devices before testing.
 6. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating.
 7. Fill each section with water and pressurize for indicated pressure and time.
 8. Provide air vents at all high points in the system to purge air pockets while the system is filling.
- C. Test Pressure:
1. The hydrostatic test pressure shall be as defined in Paragraph 137 of the ASME B31.1 Power Piping Code. If in doubt, refer to the Director's Representative.
 2. Continuously maintain the test pressure for a minimum time of 2 hours. During this 2 hour period, no pressure drop shall be measured.
 3. After the 2 hour period, if necessary, reduce the pressure to design pressure, and hold for such time as may be necessary to continue to conduct examinations for leakage.
 4. Make examinations for leakage on all joints and connections.
 5. The piping system shall show no visual evidence of weeping or leaking.
 6. Hydrostatic testing shall be witnessed by the Director's Representative.
 7. Repeat tests after any leaks are found, and then corrected.

- D. Test Blinds:
 - 1. Provide test blinds in any part of the piping when required during the field testing of piping.
 - 2. Equip test blinds with a long handle.
 - 3. Submit a written description of the location of test blinds before testing.
 - 4. Remove all test blinds after testing.
- E. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage.
 - 1. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- F. Records:
 - 1. Maintain accurate, updated records of all hydrostatic testing.
 - a. Submit a final log of all hydrostatic testing for the Director's Representative's records.
 - 2. Maintain a constantly updated listed of the following for all hydrostatic tests:
 - a. Date and time of test.
 - b. Hydrostatic test pressure.
 - c. Piping system tested.
 - d. Extent of piping system tested so that it can be clearly identified up to what point a piping system has been tested.
 - e. Test results. All failures shall be indicated with the cause explicitly stated.
 - f. The Director's Representative and the Contractor shall witness each test.

3.04 TESTING OF EQUIPMENT, APPARATUS AND APPURTENANCES

- A. Low Pressure Steam Boilers: Perform hydrostatic test at 15 psig after installation with all piping connections shut-off.
- B. Hot Water Boilers: Perform hydrostatic test at 60 psig, after installation, with piping connections shut-off.
- C. Relief Valves: Increase pressure in equipment or apparatus to relief valve setting, to test opening of valves at required relief pressures.

3.05 HEATING, VENTILATING AND AIR CONDITIONING SYSTEMS - CLEANING AND OPERATIONAL TESTING

- A. Circulating Heating Hot Water and Chilled Water Systems in Buildings:
 - 1. Cleaning:
 - a. Flush systems and apparatus, upon completion of pressure test(s).
 - b. Completely open valves and flush each system with clean water, prior to chemical cleaning.
 - c. Repeatedly flush at short intervals until twice the system water capacity has been flushed through.

- d. Chemically clean systems immediately following flushing operations.
 - e. Circulate a solution consisting of trisodium phosphate, in a proportion of one pound of chemical to every 50 gallons of water in the system.
 - f. Completely fill system with cleaning solution; vent as required, and place in operation, with automatic controls operating and valves fully open.
 - g. Allow system to reach design operating temperature or an operating temperature designated by the Director's Representative.
 - h. Circulate the solution through the system for a minimum of 4 consecutive hours; immediately drain system and flush with clean water until the pH at the farthest drain matches the clean water input.
 - i. Provide temporary pipe and /or hose required to drain system.
 - j. Keep strainers unplugged during cleaning operations. Remove and clean strainer screens prior to operational test.
 - k. Refill system with clean water and correct pH to 7.
 - l. Do not flush steam piping thru steam coils. Provide temporary steam supply and condensate piping to bypass steam coils.
 - m. Upon completion of flushing, remove temporary piping and reconnect steam coil.
 2. Operational Test:
 - a. Run system in an automatic mode for a minimum of 120 consecutive hours.
 - b. During this time, make final adjustments, including the setting of the balancing valves.
- B. Propylene Glycol Systems:
 1. Clean as specified for circulating water systems.
 2. Perform operational test as specified for circulating water systems with propylene glycol solution in system.
- C. Steam Heating Systems (N/A)
 1. Cleaning:
 - a. Upon completion of pressure test(s), place the system in automatic operation, at a minimum 15 psig steam pressure unless otherwise directed by the Director's Representative.
 - b. Maintain this pressure for a minimum of 4 hours to remove dirt, sludge and foreign substances from the system.
 - c. During this time waste the condensate. Provide temporary piping to transport to transport condensate to blowdown tank.
 - d. Allow condensate to cool below 140 degrees F before wasting into sanitary drains.
 - e. Periodically blow down strainers during cleaning operations and totally clean strainers and trap elements at end of blow down.
 - f. Do not flush.
 2. Operational Test:

- a. Run system in an automatic mode for a minimum of 120 consecutive hours, with final connections made to apparatus, equipment and accessories.
 - b. Make final adjustments.
- D. High Temperature Water Piping Systems:
 - 1. Cleaning:
 - a. Upon completion of pressure test(s), steam clean piping systems.
 - b. Provide temporary piping as required to facilitate the cleaning operations.
 - c. Include drain valves at low points in the temporary piping arrangement with waste piping from each drain valve, terminating at approved points of waste where directed.
 - d. Subject piping system to a steam pressure of 10 psig for a period of 8 hours.
 - e. During the 8 hour cleaning period, crack the drain valves open. At times as directed, fully open drain valves to blow down the system; repeat this procedure until the piping is declared clean by the Director's Representative.
 - f. Provide a temporary steam generator, with necessary appurtenances, of capacity to supply and maintain a 10 psig steam pressure on the piping system for steam cleaning purposes.
 - g. Water and electric power will be available at the building, in which the piping system is installed.
 - h. Remove the temporary equipment and appurtenances upon completion of cleaning.
 - 2. Operational Test:
 - a. Run system in an automatic mode for a minimum of 120 consecutive hours.
 - b. During this time make final adjustments.

3.06 REFRIGERATION SYSTEMS - TESTING, DEHYDRATION AND CHARGING (N/A)

- A. Leak Test Procedure:
 - 1. Refrigerant Piping Systems:
 - a. Pressurize with dry nitrogen to 50 psig and test for leaks using a bubble type solution.
 - b. Release this partial test pressure and correct deficiencies.
 - c. Charge system with a trace of refrigerant to 15 psig, then add dry nitrogen until system test pressures are reached and retest for leaks with an electronic leak detector.
 - d. Release pressure, repair leaks and retest as necessary until no leaks occur.
 - e. Recover refrigerant used for leak testing.
 - 2. System Test Pressures:
 - a. Charge system with dry nitrogen and trace of refrigerant (HFC 134A, HFC 245, HFC 404, HFC 407C, HFC 410A or HFC 507) to 350 psig and retest for leaks with an electronic leak detector. The system must stay at 350 psig pressure for 24 hours to pass the system test pressure test.

- b. Release pressure, repair leaks and retest as necessary until no leaks occur.
 - c. Recover refrigerant used for leak testing.
- B. Dehydration:
 - 1. Low and Ultra Low Temperature Refrigeration Systems (-30 degrees F to 32 degrees F:
 - a. Following pressure tests, dehydrate each system with a vacuum pump.
 - b. Draw and hold an initial vacuum of 800 microns. Break this vacuum by pressurizing with dry nitrogen to 10 psig, and change oil in vacuum pump.
 - c. Draw and hold a second vacuum of 500 microns. Break this vacuum by pressurizing with dry nitrogen to 10 psig, and change oil in vacuum pump.
 - d. Draw and hold a third vacuum of 250 microns for 8 to 12 hours with an allowable maximum rise of 50 microns. Break this third vacuum by adding liquid refrigerant specified for the equipment to the high side of the system (liquid line).
 - e. Verify vacuum obtained with an electronic vacuum gage.
 - 2. Medium Temperature Refrigeration Systems (33 degrees F to 55degrees F), and Air Conditioning Systems:
 - a. Following pressure tests, dehydrate each system with a vacuum pump.
 - b. Draw and hold an initial vacuum of 500 microns. Break this vacuum by pressurizing with dry nitrogen to 10 psig, and change oil in vacuum pump.
 - c. Draw and hold a second vacuum of 500 microns. Break this vacuum by pressurizing with dry nitrogen to 10 psig, and change oil in vacuum pump.
 - d. Verify vacuum obtained with an electronic vacuum gage.
- C. Refrigerant Charging: Follow equipment manufacturer's printed charging directions unless otherwise specified.
 - 1. Introduce refrigerant of type and quantity required through a filter/drier installed in the temporary charging line.
 - a. Purge small amount of liquid out of the system side of the charging hose.
 - b. Prevent moisture and other contaminants from entering the system.
 - 2. Charge liquid refrigerant through a charging valve provided in the high pressure side of the system.
 - a. Small amounts of gaseous refrigerant may be charged through the compressor suction service valve port.
 - 3. No bubbles shall appear at the moisture-liquid indicator when the system is fully charged and operational. Do not overcharge.
 - 4. Record the weight in pounds of refrigerant charged into each system and submit this record to the Director's Representative.

- D. Compressor Oil Charge: Pump oil into the compressor after the last vacuum has been performed. Follow all Manufactures Recommended for oil type and amount to be installed.
- E. Adjustments and Operational Testing:
 - 1. Adjustments: Place the system in operation with automatic controls functioning. Adjust controls and apparatus for proper operation. Test thermometers and gages for accuracy over the entire range. Remove and replace items found defective.
 - a. Check belts, fan blades, fittings, TXV bulbs, and electrical connections for tightness before start up.
 - b. Check TXV bulb for proper location should be between 8 and 10 o'clock or 2 & 4 o'clock.
 - c. Seal off all holes in the condition space as specified.
 - d. Provide a point to point control check of the system to ensure that the specified inputs and outputs are receiving the signal from the proper sensors or controlling the proper device.
 - e. Set pressure controls and safety controls.
 - f. Close or de-energize all solenoids, and start up the system.
 - g. Check that all controls and safety switches are operating properly.
 - h. Adjust TXV for proper super heat back to the compressors.
 - i. Clean TXV strainers as many times as required.
 - j. After one week of run time, change the liquid cores if they are the replaceable type.
 - k. After one month of run time, replace the liquid cores and compressor suction socks. Replace the liquid cores as required. Clean the TXV's as required.
 - 2. Operational Test:
 - a. Place system in operation, with final connections to equipment and with automatic controls operating, and operate for a minimum of 120 consecutive hours.
 - b. Operational test shall prove to the satisfaction of the Director's Representative that the system can produce the cooling effect required by the drawings and the specifications.

3.07 DISINFECTION OF POTABLE WATER SYSTEMS

- A. Disinfect potable water pipe and equipment installed in the Work of this Contract.
 - 1. Completely fill the piping, including water storage equipment if installed, with a water solution containing 50 mg/L available chlorine, and allow stand for 24 hours.
 - 2. Operate all valves during this period to assure their proper disinfection.
 - 3. After the retention period, discharge the solution to an approved waste and flush the system thoroughly with water until substantially all traces of chlorine are removed.
 - 4. Drain and flush water storage equipment if installed.
- B. Connect plumbing fixtures and equipment and place the system into service. Prevent recontamination of the piping during this phase of the Work.

END OF SECTION

SECTION 230594

BALANCING OF SYSTEMS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Systems Cleaning, Pressure and Operational Testing: Section 230593.

1.02 SUBMITTALS

- A. Quality Control Submittals:
1. Testing, Adjustment and Balancing Reports:
 - a. Hydronic Systems: Submit results on Form BDC-374, which can be obtained from the Director's Representative or use a similar test report form which includes all of the items and data included on Form BDC-374.
 - b. Air Systems: Submit results on Forms BDC-340 which can be obtained from the Director's Representative, or use similar test report forms, which includes all the items and data included on Forms BDC-340.
 - c. Submit final testing and balancing results on applicable report forms, as approved or furnished by the environmental systems balancing council or bureau, which is certifying the independent member agency performing the Work, required by this Section. Each final systems report form shall bear the signature of the person performing the Work and recording the data and the signature of the certified supervisor for the performing agency. Submit simultaneously with the final reports, a list of the instruments used with the last date of calibration for each instrument.

1.03 QUALITY ASSURANCE

- A. Qualifications:
1. Provide the services of a certified independent agency for the testing, adjustment and balancing of all air distribution and hydronic distribution systems complete with all connected apparatus and equipment. The agency shall be certified by the Associated Air Balance Council Bureau - AABC, Los Angeles, Cal. 90026 or by National Environmental Balancing Bureau - NEBB, Arlington, Va. 22209.
 2. The Work shall be performed by skilled mechanical technicians under the direct supervision of certified personnel in the employ of the independent agency. The supervisor shall be personally certified by the national council or bureau, as approved by the Director.

1.04 SEQUENCING AND SCHEDULING

- A. Scheduling:

1. Perform environmental systems testing and balancing after cleaning, miscellaneous testing, adjustment and operational testing Work has been completed.
2. Test and balance system during a period of time when outside temperature conditions will impose a significant load on the system; i.e., summer months for air conditioning system, winter months for heating system. Balance and adjust systems accordingly.
3. Send written notification to the Director a minimum of five days prior to the performance of testing and balancing Work. Perform testing and balancing Work in the presence of the Director's Representative.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A. General Information: Test instruments are included in this specification for information only. Balancing of air and hydronic systems shall be performed by qualified personnel utilizing company owned test instruments, which will remain the property of the company. Use test instruments which are in first class operating condition, with individual calibration histories to guarantee their accuracy. Test instruments shall be of type and kind as required by the type of system installed. Trade names and manufacturer's names are mentioned in this section for descriptive purposes only; instruments of equivalent range and capabilities may be utilized.
- B. Air Balancing Instruments:
 1. Manometers: Inclined with ranges of 0 to 1/4 inch and 0 to 1 inch; Combination inclined and vertical with a range of 0 to 5 inches and U tube type, 18 inches.
 2. Portable "Magnehelic" Draft Gages: Ranges 0 to 1/2 inch, 0 to 1 inch and 0 to 5 inches.
 3. Anemometers: Deflecting vane type with a range of 100 to 3000 fpm, similar to Alnor Velometer Model 6000 BP and 4 inches diameter rotating vane type.
 4. Pitot Tubes: ASHRAE standard type, stainless steel, 5/16 inch diameter, lengths as required.
 5. Sling Psychrometer.
 6. Smoke Candles and Smoke Generator.
- C. Hydronic Balancing Instruments:
 1. Calibrated Test Gages: Ranges 0 to 30 lbs., 0 to 60 lbs., 0 to 200 lbs.
 2. Calibrated Test Gages (Compound Type): Ranges from -30 inches to 30 lbs. and -30 inches to 60 lbs.
 3. U Tube Manometer: 36 inches.
- D. Air and Hydronic Systems Balancing Instruments:
 1. Thermometers: 12 inches mercury column type and dial type, with a range of -40 to +120 degrees F. and 0 to 220 degrees F. Total of four thermometers.
 2. Universal Hand Tachometer: Herman H. Sticht Type UH.

3. Stop Watch.
4. Stroboscope.
5. Contact Pyrometer: Thermocouple type.
6. Volt-Ohm-Ammeter Test Kit, High Current Type: Sperry "Ohmprobe".
7. Volt-Ammeter: With leads for connecting to lugs.

PART 3 EXECUTION

3.01 PRELIMINARY WORK

- A. Circulating Water Systems: Prior to balancing the system, bleed all air vents so as to completely flood the system; check pumps for proper rotation; clean strainers and set balancing and system stop valves in the full-open position.
- B. Ventilating and Air Conditioning Systems: Prior to balancing the system, check fans for proper rotation; check filters for cleanliness and proper installation and set dampers in the normal operating position.

3.02 BALANCING OF CIRCULATING WATER SYSTEM AND ETHYLENE GLYCOL SYSTEMS

- A. Equipment Schedules and Report Sheets: Prepare itemized equipment schedules, listing all heating or cooling elements and equipment in the system to be balanced. List in order on equipment schedules, by pump or zone according to the design, all heating or cooling elements and all zone balancing valves or balancing devices. Break down schedules into zones to circuits, starting from the zone or circuit pump and terminating with the last item of equipment or transfer element in the respective zone or circuit. Include on schedule sheets, column titles listing the location, type of element or apparatus, design conditions and water balance readings. Prepare individual pump report sheets for each individual system or zone pump.
- B. Balancing:
 1. Place system in full automatic operation, with automatic controls set in accordance with design conditions, and allow water to reach design temperature.
 2. Test pumps and balance flow. Record the following on pump report sheets:
 - a. Suction and discharge pressure.
 - b. Running amps and brake horsepower of pump motor under full flow and no flow conditions.
 - c. Pressure drop across pump in feet of water and total gpm pump is handling under full flow conditions.
 3. Set zone or circuit balancing valve at each pump, to handle the design GPM.
 4. When the design incorporates the use of air handling units containing coils, check and adjust each unit to insure the proper volume of air is passing through the coils, while the balancing procedure is in progress.
 5. Check pumps for flow, after the system has been balanced.
 6. Record test readings, calculations and results.

3.03 BALANCING OF VENTILATING AND AIR CONDITIONING SYSTEMS

- A. Equipment Schedules and Report Sheets:
 - 1. Prepare itemized air balance schedules for each system listing all air handling units and air outlets for each system. Schedule multi-zone systems by individual zones. Start each schedule from the inlet or the air handling unit and terminate with the last air inlet or outlet device in the system or zone.
 - 2. Prepare individual air handling unit report sheets, noting manufacturer's published performance data.
 - 3. Record all test readings, calculations and results.
- B. Balancing:
 - 1. Inspect All Equipment: Establish a definite operational test condition for test and air balance purposes. In accordance with test condition selected, such as minimum fresh air dampers open, turn on all air handling systems in the building, including all exhaust systems.
 - 2. Balance a system starting with the air handling unit. Check fan speed, using a tachometer with a self-timing device and the power reading of the fan motor using a volt-amp meter. Calculate the actual brake horse power from the tachometer and volt-amp meter readings. Compare the actual fan speed reading and the motor power reading, with the air handling unit manufacturer's published performance data, and if they check within reasonable limits, make duct velocity readings on the main ducts. Drill holes in the main ducts and using a velocity measuring instrument take velocity readings. Take velocity readings in each zone duct of a multi-zone system and in addition, in the main branch ducts of a reheat type system. Close and seal test holes with metal snap hole plugs and duct tape. Calculate the cfms of the ducts. Establish the total air for the fan or system under test. Compare the design data with the test results, and if the total air is high or low, adjust the fan speed accordingly. Repeat the described test procedure for all air handling units, including all supply air, return air and exhaust air apparatus. With the total air for the system established, use the same duct velocity check system for adjusting the main splitter dampers or other volume control devices for the various branches of the system. Test and adjust the individual air inlet or outlet devices, after the main ducts, zone ducts and branch ducts have been set at design conditions. Adjust individual air inlet and outlet devices, such as registers and diffusers, for air pattern and volume, in the manner recommended by the manufacturer of the devices. The total cfm of all inlets or outlets shall equal the total cfm of all branches, which in turn shall equal the total air volume of the air handling units. The system is balanced, when the results of the specified test procedures check with the design data, that is, fan speed and horsepower; total air by velocity readings and total air by inlet or outlet volume.

3.04 FIELD QUALITY CONTROL

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- A. Inspection: Prior to the environmental testing and balancing of hydronic and air distribution systems, the certified supervisor in the employ of the testing and balancing agency shall inspect the installations and notify the Director's Representative of any Work which must be performed or modified prior to initiating testing and balancing procedures.
- B. Performance: Test and balance environmental hydronic and air distribution systems, including all connected equipment and apparatus, so as to conform to the design conditions. Perform the Work of this section in accordance with the published standards of the balancing council or bureau, which is certifying the member firm. Record all test readings, calculations and results.

END OF SECTION

SECTION 230719

INSULATION

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Through Penetration Firestops: Section 078401.
- B. Painting: Section 099103.
- C. Pipe Hangers and Supports: Section 230529.

1.02 ABBREVIATIONS

- A. FS: Federal Specification.
- B. K: Thermal Conductivity, i.e., maximum Btu per inch thickness per hour per square foot.
- C. pcf: Pounds per cubic foot.
- D. PVC: Polyvinylchloride.

1.03 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's catalog sheets, specifications and installation instructions for insulation materials and jacket materials.
 - 2. Materials Schedule: Itemize insulation materials and thicknesses for each specified application in Insulation Material Schedules in Part 3 of this Section. Where optional materials are specified, indicate option selected.
- B. Quality Control Submittals:
 - 1. Installers Qualification Data:
 - a. Name of each person who will be performing the Work, and their employer's name, business address and telephone number.
 - b. Furnish names and addresses of the required number of similar projects that each person has worked on which meet the qualifications.

1.04 QUALITY ASSURANCE

- A. Qualifications: The persons installing the Work of this Section and their Supervisor shall be personally experienced in mechanical insulation work and shall have been regularly employed by a company installing mechanical insulation for a minimum of 5 years.

- B. Regulatory Requirements:
 - 1. Insulation installed inside buildings, including duct lining materials, laminated jackets, mastics, sealants and adhesives shall have a Fire Spread/Smoke Developed Rating of 25/50 or less based on ASTM E 84.

PART 2 PRODUCTS

2.01 INSULATION

- A. Fibrous Glass (Mineral Fiber) Insulation: Composed principally of fibers manufactured from rock, slag, or glass, with or without binders, and asbestos free.
 - 1. Preformed Pipe Insulation: Minimum density 3 pcf; ASTM C 547:
 - a. Class 1 (Suitable for Temperatures Up to 450 degrees F): K of 0.26 at 75 degrees F.
 - b. Class 2 (Suitable for Temperatures 451 to 650 degrees F): K of 0.46 at 300 degrees F.
 - c. Class 3 (Suitable for Temperatures 651 to 1200 degrees F): K of 0.56 at 300 degrees F.
 - 2. Premolded Fitting Insulation: Minimum density 4.0 pcf, K of 0.26 at 75 degrees F; ASTM C 547, Class 1.
 - 3. Insulation Inserts for PVC Fitting Jackets: Minimum density 1.5 pcf, K of 0.28 at 75 degrees F; ASTM C 553, Type III.
 - a. Suitable for temperatures up to 450 degrees F.
 - 4. Block or Board Insulation: Minimum density 3.0 pcf and 6.0 pcf as specified; ASTM C 612:
 - a. Type IA or IB (Suitable for Temperatures Up to 450 degrees F): K of 0.26 at 75 degrees F.
 - b. Type II (Suitable for Temperatures 451 to 850 degrees F): K of 0.44 at 300 degrees F.
 - c. Type III (Suitable for Temperatures 851 to 1000 degrees F): K of 0.44 at 300 degrees F.
 - d. Type IV (Suitable for Temperatures 1001 to 1200 degrees F): K of 0.37 at 300 degrees F.
 - e. Type V (Suitable for Temperatures 1201 to 1800 degrees F): K of 0.42 at 300 degrees F.
 - 5. Thermal and Acoustic Board Insulation: Minimum density 3.0 pcf, K of 0.27 at 75 degrees F; ASTM C 1071, Type II.
 - a. Air Stream Side: Erosion, temperature, and fire resistant type; NFPA 90-A and 90-B.
 - 6. Blanket Insulation:
 - a. For Ductwork (Suitable for Temperatures Up to 450 Degrees F): Minimum density 1.0 pcf, K of 0.31 at 75 degrees F; ASTM C 553, Type II.
 - b. For Breeching (Suitable for Temperatures up to 1200 degrees F): Minimum density 8 pcf, K of 0.55 at 400 degrees F, metal mesh faced one side; ASTM C 553, Type VII.
- B. Flexible Elastomeric Foam Insulation:
 - 1. FM tested and approved, meeting the following:

- a. Maximum Water Vapor Transmission: 0.10 perm - inch based on ASTM E 96, Procedure A.
 - b. K of 0.27 at 75 degrees F based on ASTM C 518 or C 177.
 - c. Fire Spread/Smoke Developed Rating: 25/50 or less based on ASTM E 84.
 2. Pipe Insulation: ASTM C 534, Type I.
 3. Sheet Insulation for Ductwork and Equipment: ASTM C 534, Type II, smooth skin one side.
 4. Polyethylene and polyolefin insulation is not acceptable.
- C. High Density Jacketed Insulation Inserts for Hangers and Supports:
 1. For Use with Fibrous Glass Insulation:
 - a. Cold Service Piping:
 - 1) Polyurethane Foam: Minimum density 4 pcf, K of 0.13 at 75 degrees F, minimum compressive strength of 125 psi.
 - b. Hot Service Piping:
 - 1) Calcium Silicate: Minimum density 15 pcf, K of 0.50 at 300 degrees F; ASTM C 533.
 - 2) Perlite: Minimum density 12 pcf, K of 0.60 at 300 degrees F; ASTM C 610.
 - c. Ductwork: Fibrous glass board, minimum density 6 pcf, K of 0.26 at 75 degrees F, conforming to ASTM C 612, Type IA or IB.
 2. For Use with Flexible Elastomeric Foam Insulation:
 - a. Ductwork and Piping: Hardwood dowels and blocks, length or thickness equal to insulation thickness, other dimensions as specified or required.
- D. Cements:
 1. Fibrous Glass Thermal Insulating Cement: Asbestos free; ASTM C 195.
 2. Fibrous Glass Hydraulic Setting Thermal Insulating and Finishing Cement: ASTM C 449/C 449M.

2.02 JACKETS

- A. Laminated Vapor Barrier Jackets for Piping and Ductwork: Factory applied by insulation manufacturer, conforming to ASTM C 1136, Types I and II.
 1. Type I: Reinforced white kraft and aluminum foil laminate with kraft facing out.
 - a. Pipe Jackets: Furnished with integral 1-1/2 inch self sealing longitudinal lap, and separate 3 inch wide adhesive backed butt strips.
 2. Type II: Reinforced aluminum foil and kraft laminate with foil facing out.
 3. Laminated vapor barrier jackets are not required for flexible elastomeric foam insulation.
- B. Canvas Jackets: Cotton duck, fire retardant, complying with NFPA 701, 4 oz or 6 oz per sq yd as specified.

- C. Premolded PVC Fitting Jackets:
 - 1. Constructed of high impact, UV resistant PVC.
 - a. ASTM D 1784, Class 14253-C.
 - b. Working Temperature: 0-150 degrees F.
- D. Metal Jacketing:
 - 1. Aluminum: ASTM B 209, Alloys 1100, 30003, 3105 or 5005, Temper H14, 0.016 inch thick.
 - a. Factory Pre-formed Sectional Pipe Jacketing:
 - 1) Smooth outer finish with integral bonded laminated polyethylene film - kraft paper moisture barrier underside.
 - 2) Pittsburg or modified Pittsburg longitudinal lock seams.
 - 3) 2 inch overlapping circumferential joints with integral locking clips, or butt joints sealed with 2 inch wide mastic backed aluminum snap bands.
 - b. Roll Jacketing: Smooth outer finish with integral bonded laminated polyethylene film - kraft paper moisture barrier underside.
 - c. Sheet Jacketing: Corrugated 1-1/4 inch x 1/4 inch deep with integral bonded laminated polyethylene film - kraft paper moisture barrier underside.
 - d. Fastening Devices:
 - 1) Strapping: Type 18-8 stainless steel, 0.020 inch thick, 1/2 and 3/4 inch wide as specified.
 - 2) Wing Seals: Type 18-8 stainless steel, 0.032 inch thick.
 - 3) Sheet Metal Screws: Panhead, Type A, hardened aluminum, and stainless steel.
 - 2. Circumferentially Corrugated Aluminum Jacketing: Childers' Corrolon.
 - a. Construction: 3/16 inch circumferentially corrugated embossed aluminum, ASTM B 209, Types 1100, 3003, 3105, or 505, H-14 temper, 0.016 inch thick.
 - b. Moisture Barrier: Integrally bonded to jacket over entire surface in contact with insulation.
 - c. Fastening Devices:
 - 1) Strapping: 0.020 inch thick by 1/2 inch wide, Type 3003, 3105, 5005, H-14 temper.
 - 2) Wing Seals: 0.032 inch thick Type 5005, H-14 temper aluminum.

2.03 ADHESIVES, MASTICS, AND SEALERS

- A. Lagging Adhesive (Canvas Jackets): Childers' CP-50AMV1, Epolux's Cadalag 336, Foster's 30-36.
- B. Vapor Lap Seal Adhesive (Fibrous Glass Insulation): Childers' CP-82, Epolux's Cadoprene 400, Foster's 85-60 or 85-20.

- C. Vapor Barrier Mastic (Fibrous Glass Insulation): Permeance shall be .03 perms or less at 45 mils dry per ASTM E 96. Childers' CP-34, Epolux's Cadalar 670, Foster's 30-65 .
- D. Adhesive (Flexible Elastomeric Foam): Armstrong's 520, Childers' CP-82, Epolux's Cadoprene 488, Foster's 85-75. 5 gallon cans only.
- E. Adhesive (Fiberglass duct liner): Childers' Chil Quik CP-127, Foster Vapor Fas 85-60. Must comply with ASTM C 916, Type II
- F. Weather Barrier Breather Mastic (Reinforcing Membrane): Childers' VI-CRYL CP-10/11, Foster's Weatherite 46-50.
- G. Sealant (Metal Pipe Jacket): Non hardening elastomeric sealants. Foster Elastolar 95-44, Childers Chil Byl CP-76, Pittsburgh Corning 727.
- H. Reinforcing Membrane: Childers' Chil Glas #10, Foster Mast a Fab, Pittsburgh Corning PC 79

2.04 MISCELLANEOUS MATERIALS

- A. Insulation Fasteners for Ductwork and Equipment:
 - 1. Acceptable Manufacturers: Duro-Dyne Corp.; Erico Fastening Systems, Inc.
 - 2. Type: Weld pins, complete with self-locking insulation retaining washers.
- B. Pressure Sensitive Tape for Sealing Laminated Jackets:
 - 1. Acceptable Manufacturers: Alpha Associates, Ideal Tape, Morgan Adhesive.
 - 2. Type: Same construction as jacket.
- C. Wire, Bands, and Wire Mesh:
 - 1. Binding and Lacing Wire: Nickel copper alloy or copper clad steel, gage as specified.
 - 2. Bands: Galvanized steel, 1/2 inch wide x 0.015 inch thick, with 0.032 inch thick galvanized wing seals.
 - 3. Wire Mesh: Woven 20 gage steel wire with 1 inch hexagonal openings, galvanized after weaving.
- D. Metal Corner Angles: Galvanized steel, 2 x 2 inch 28 gage.
- E. Reinforcing Membrane: Glass or Polyester, 10 x 10 mesh. Alpha Associates Style 59, Childer's Chil-Glas, Foster's MAST-A-FAB.

PART 3 EXECUTION

3.01 PREPARATION

- A. Perform the following before starting insulation Work:

1. Install hangers, supports and appurtenances in their permanent locations.
2. Complete testing of piping, ductwork, and equipment.
3. Clean and dry surfaces to be insulated.

3.02 INSTALLATION, GENERAL

- A. Install the Work of this Section in accordance with the manufacturer's printed installation instructions unless otherwise specified.
- B. Piping Insulation: Provide continuous insulation and jacketing when passing thru interior wall, floor, and ceiling construction.
 1. At Through Penetration Firestops: Coordinate insulation densities with the requirements of approved firestop system being installed. See Section 078400.
 - a. Insulation densities required by approved firestop system may vary with the densities specified in this Section. When this occurs use the higher density insulation.
- C. Do not intermix different insulation materials on individual runs of piping.

3.03 INSTALLATION AT HANGERS AND SUPPORTS

- A. Reset and realign hangers and supports if they are displaced while installing insulation.
- B. Install high density jacketed insulation inserts at hangers and supports for insulated ductwork, piping, and equipment.
- C. Insulation Inserts For Use with Fibrous Glass Insulation:
 1. Ductwork: Install 6 pcf density jacketed fibrous glass board, same thickness as adjoining insulation, sized for full bearing on supporting trapeze member, and as required to enable abutting to adjoining insulation and overlapping of jacketing.
 2. Piping: Where clevis hangers are used, install insulation shields and high density jacketed insulation inserts between shield and pipe.
 - a. Where insulation is subject to compression at points over 180 degrees apart, e.g. riser clamps, U-bolts, trapezes, etc.; fully encircle pipe with 2 protection shields and 2 high density jacketed fibrous glass insulation inserts within supporting members.
 - 1) Exception: Locations where pipe covering protection saddles are specified for hot service piping, 6 inch and larger.
- D. Insulation Inserts For Use with Flexible Elastomeric Foam Insulation:
 1. Ductwork: Install hardwood block, same thickness as adjoining insulation, sized for full bearing on supporting trapeze member and as required to abutt and seal vapor tight with adjoining insulation.
 2. Piping:
 - a. Where clevis hangers are used, install insulation shields with hardwood filler pieces, same thickness as adjoining insulation,

- inserted in undersized die cut or slotted holes in insulation at support points.
- b. Contour hardwood blocks to match the curvature of pipe, and shield.
- c. Coat dowels and blocks with insulation adhesive, and insert while still wet.
- d. Vapor seal outer surfaces of dowels and blocks with adhesive after insertion.
- e. Install filler pieces as follows:

PIPE/TUBING SIZE	FILLER PIECES	POSITION
Thru 1-1/2"	2 dowel plugs	6 o'clock; in tandem
2" thru 4"	1 block 2 dowel plugs	6 o'clock, and 4 & 8 o'clock respectively
6" thru 8"	2 blocks 4 dowel plugs	6 o'clock; in tandem and 4 & 8 o'clock; in tandem

3.04 INSTALLATION OF FIBROUS GLASS COLD SERVICE INSULATION

- A. Install insulation materials with a field or factory applied ASTM C 1136 Type I laminated vapor barrier jacket, unless otherwise specified.
- B. Piping:
 - 1. Butt insulation joints together, continuously seal minimum 1-1/2 inch wide self sealing longitudinal jacket laps and 3 inch wide butt adhesive backed strips.
 - a. Substitution: 3 inch wide pressure sensitive sealing tape, of same material as jacket, may be used in lieu of butt strips.
 - 2. Bed insulation in a 2 inch wide band of vapor barrier mastic, and vapor seal exposed ends of insulation with vapor barrier mastic at each butt joint between pipe insulation and equipment, fittings or flanges at the following intervals:
 - a. Horizontal Pipe Runs: 21 ft.
 - b. Vertical Pipe Runs: 9 ft.
- C. Fittings, Valves, Flanges and Irregular Surfaces:
 - 1. Insulate with mitre cut or premolded fitting insulation of same material and thickness as pipe insulation.
 - 2. Secure insulation in place with 16 gage wire, with ends twisted and turned down into insulation.
 - 3. Butt insulation against pipe insulation and bond with joint sealer.
 - 4. Insulate valves up to and including bonnets, without interfering with packing nuts.
 - 5. Apply leveling coat of insulating cement to smooth out insulation and cover wiring.
 - 6. When insulating cement has dried, seal fitting, valve and flange insulation, by imbedding a layer of reinforcing membrane or 4 oz. canvas jacket between 2 flood coats of vapor barrier mastic, each 1/8 inch thick wet.

7. Lap reinforcing membrane or canvas on itself and adjoining pipe insulation at least 2 inches.
8. Trowel, brush or rubber glove outside coat over entire insulated surface.
9. Exceptions:
 - a. In Mechanical Equipment Rooms, Steam Service Rooms, Machine Rooms, Boiler Rooms, Penthouses, Finished Rooms and Finished Spaces: Cover fittings, valves and flanges insulated with fibrous glass with an additional 6 oz canvas jacket, lapped on adjoining insulation and pasted with lagging adhesive.
 - b. Type C and D Piping Systems: Valves, fittings and flanges may be insulated with premolded PVC fitting jackets, with fibrous glass insulation inserts.
 - 1) Additional insulation inserts are required for services with operating temperatures under 45 degrees F or where insulation thickness exceeds 1-1/2 inches. The surface temperature of PVC fitting jacket must not go below 45 degrees F.

3.05 INSTALLATION OF FIBROUS GLASS HOT SERVICE INSULATION

- A. Install insulation materials with field or factory applied ASTM C 1136 Type I laminated vapor barrier jacket unless otherwise specified.
- B. Canvas Jackets on Piping, Fittings, Valves, Flanges, Unions, and Irregular Surfaces:
 1. For Piping 2 inch Size and Smaller: 4 oz per sq yd unless otherwise specified.
 2. For Piping Over 2 inch Size: 6 oz per sq yd unless otherwise specified.
- C. Piping:
 1. Butt insulation joints together, continuously seal minimum 1-1/2 inch wide self sealing longitudinal jacket laps and 3 inch wide adhesive backed butt strips.
 - a. Substitution: 3 inch wide pressure sensitive sealing tape, of same material as the jacket, may be used in lieu of butt strips.
 2. Fill voids in insulation at hanger with insulating cement.
 3. Exceptions:
 - a. Piping in Accessible Shafts, Attic Spaces, Crawl Spaces, Unfinished Spaces and Concealed Piping: Butt insulation joints together and secure minimum 1-1/2 inch wide longitudinal jacket laps and 3 inch wide butt strips of same material as jacket, with outward clinching staples on maximum 4 inch centers. Fill voids in insulation at hangers with insulating cement.
 - b. Piping in Tunnels: Butt insulation joints together and secure minimum 1-1/2 inch wide longitudinal jacket laps and 3 inch wide butt strips, of same material as jacket, with outward clinching staples on maximum 4 inch centers and 16 gage wires a minimum of 4 loops per section. Fill voids in insulation with insulating cement.

- D. Fittings, Valves, Flanges and Irregular Surfaces:
1. Insulate with mitre cut or premolded fitting insulation of same material and thickness as insulation.
 2. Secure in place with 16 gage wire, with ends twisted and turned down into insulation.
 3. Butt fitting, valve and flange insulation against pipe insulation, and fill voids with insulating cement.
 4. Insulate valves up to and including bonnets, without interfering with packing nuts.
 5. Apply leveling coat of insulating cement to smooth out insulation and cover wiring.
 6. After insulating cement has dried, coat insulated surface with lagging adhesive, and apply 4 oz or 6 oz canvas jacket as required by pipe size.
 - a. Lap canvas jacket on itself and adjoining pipe insulation at least 2 inches.
 - b. Size entire canvas jacket with lagging adhesive.
 7. Exceptions:
 - a. In Types E, F and G Service Piping Systems: Valves, fittings and flanges may be insulated with premolded PVC fitting jackets, with fibrous glass insulation inserts.
 - 1) Additional insulation inserts are required for services with operating temperatures over 250 degrees F or where insulation thickness exceeds 1-1/2 inches. The surface temperature of PVC fitting jacket must not exceed 150 degrees F.
 - b. In Types E, F, and G Service Piping Systems: Insulate fittings, valves, and irregular surfaces 3 inch size and smaller with insulating cement covered with 4 oz or 6 oz canvas jacket as required by pipe size.
 - 1) Terminate pipe insulation adjacent to flanges and unions with insulating cement trowelled down to pipe on a bevel.
 - c. In Type H Service Piping System: Insulate fittings, valves, flanges, unions, and irregular surfaces 3 inch size and smaller with insulating cement covered with 4 oz or 6 oz canvas jacket as required by pipe size.
 - d. Fittings, Valves, Flanges, and Irregular Surfaces In Concealed Piping, Piping in Accessible Shafts, Attic Spaces, Crawl Spaces, Unfinished Rooms, Unfinished Spaces, and Tunnels: Sizing of canvas surface is not required.
- E. Equipment:
1. Secure fibrous glass block or board insulation in place with wire or galvanized steel bands.
 - a. Small Areas: Secure insulation with 16 gage wire on maximum 6 inch centers.
 - b. Large Areas: Secure insulation with 14 gage wire or .015 inch thick by 1/2 inch wide galvanized steel bands on maximum 10 inch centers. Stagger insulation joints.

- c. Irregular Surfaces: Where application of block or board insulation is not practical, insulate with insulating cement built-up to same thickness as adjoining insulation.
2. Fill joints, voids and irregular surfaces with insulating cement, to a uniform thickness.
3. Stretch wire mesh over entire insulated surface and secure to anchors, with wire edges laced together.
4. Apply finishing cement, total of 1/2 inch thick, in 1/4 inch thick coats.
 - a. Trowel second coat to a smooth hard finish.
5. Neatly bevel insulation around manholes, handholes, cleanouts, ASME stamp, boiler manufacturer's name and catalog number.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC FOAM INSULATION

- A. Where possible, slip insulation over the pipe, and seal butt joints with adhesive.
 1. Where the slip-on technique is not possible, slit the insulation and install.
 2. Re-seal with adhesive, making sure the mating surfaces are completely joined.
- B. Insulate fittings and valves with miter cut sections. Use templates provided by the manufacturer, and assemble the cut sections in accordance with the manufacturer's printed instructions.
 1. Insulate threaded fittings and valves with sleeved fitting covers. Over lap and seal the covers to the adjoining pipe insulation with adhesive.
- C. Carefully mate and seal with adhesive all contact surfaces to maintain the integrity of the vapor barrier of the system.
- D. Insulated Covers for Pumps:
 1. Do not extend pump insulation beyond or interfere with stuffing boxes, or interfere with adjustment and servicing of parts requiring regular maintenance or operating attention.
- E. Piping Exposed Exterior to a Building, Totally Exposed to the Elements:
 1. Apply flexible elastomeric foam insulation to piping with adhesive.
 2. Apply reinforcing membrane around piping insulation with adhesive or mastic.
 3. Adhesive Applied System: Apply 2 coats of finish. See Section 099103.
 4. Mastic Applied System: Apply another coat of mastic over reinforcing membrane.

3.07 INSTALLATION OF SHEET METAL JACKETING ON PIPING

- A. Secure jacketing to insulated piping with preformed aluminum snap straps and stainless steel strapping installed with special banding wrench.
- B. Jacket exposed insulated fittings, valves and flanges with mitred sections of aluminum jacketing.
 1. Seal joints with sealant and secure with preformed aluminum bands.

2. Substitution: Factory fabricated, preformed, sectional aluminum fitting covers may be used in lieu of mitred sections of aluminum jacketing for covering fittings, valves and flanges.
3. Substitution: Factory fabricated, preformed, sectional aluminum fitting covers or premolded polyvinylchloride fitting covers may be used in lieu of mitred sections of aluminum jacketing for covering fittings, valves and flanges.

3.08 INSTALLATION OF SMOKE BREECHING AND SMOKE FLUE PIPE INSULATION

- A. Secure insulation in place with wire or galvanized steel bands unless otherwise specified.
 1. Small Areas: Secure insulation with 16 gage wire on maximum 6 inch centers.
 2. Large Areas: Secure insulation with 14 gage wire or 0.015 inch thick by 1/2 inch wide galvanized steel bands on maximum 10 inch centers.
- B. Stagger insulation joints.
- C. On irregular surfaces, where application of block or board insulation is not practical, insulate with insulating cement built-up to same thickness as adjoining insulation.
- D. Fill joints, voids and irregular surfaces with insulating cement, to a uniform thickness.
- E. Install aluminum roll jacketing on insulated surfaces of round smoke breeching, and smoke flue pipe.
- F. Install aluminum sheet jacketing on insulated surfaces of rectangular breeching.
- G. Lap longitudinal and circumferential joints a minimum of 2 inches.
- H. Secure jacketing in place with 1/2 inch by 0.020 inch thick stainless steel bands and stainless steel wing type seals, on maximum 12 inch centers.
- I. Terminate exposed ends of insulation with insulating cement trowelled down to metal surface on a bevel.
- J. Insulate exterior surfaces of smoke breeching, induced draft fans and gas uptake ducts from medium and high pressure steam boilers and high temperature water boilers to the breeching, and any portion of the gas outlet outside the boiler brickwork, as shown on the drawings.
- K. Insulate vertical steel smoke stacks as shown in detail on the drawings.

3.09 INSTALLATION OF DUCTWORK INSULATION

- A. Fibrous Glass Board Insulation Application:

1. Secure insulation to ductwork, with duct insulation fasteners spaced 3 inch in from all corners of ducts, with intermediate fasteners on maximum 16 inch centers in all directions.
2. Butt edges of insulation and fill voids with similar insulation.
3. Seal minimum 1-1/2 inch wide longitudinal jacket laps continuously with vapor seal adhesive.
4. Lap circumferential joints with 4 inch wide jacket material and seal laps continuously with vapor barrier lap adhesive, or seal continuously with minimum 3 inch wide pressure sensitive sealing tape, of same material as jacket.
5. Install metal corner angles over the jacketed insulated corners. Seal exposed ends of insulation with vapor barrier mastic.
6. Vapor seal breaks in vapor barrier jacketing, exposed surfaces of duct insulation fasteners and metal corner angles, with pressure sensitive sealing tape of same material as jacket or coat with vapor barrier mastic.
7. Field apply 6 oz canvas jacket over the vapor barrier jacketed insulation where indicated on Ductwork Service Insulation Material Schedule in Part 3 of this Section.
 - a. Apply canvas jacket with lagging adhesive, with a 2 inch lap on circumferential and longitudinal seams.
 - b. Outward clinching staples may be utilized for additional securement of canvas to bottom of ducts in excess of 48 inch in width.
 - c. Apply heavy coat of lagging adhesive to entire canvas surface.
8. Place trapeze hangers, fabricated of steel rods and structural steel channels or angles, outside of jacketed insulated ducts.
 - a. Install high density insulation inserts, of thickness equal to insulation, minimum of 4 inch in width by the bottom dimension of the duct, at points of support.
 - b. Continuously jacket insulated ducts and filler pieces through supports.

B. Fibrous Glass Blanket Insulation Application:

1. Cut insulation to stretch-out dimensions as recommended by insulation manufacturer.
2. Remove 2 inch wide strip of insulation material from the jacketing on the longitudinal and circumferential joint edges to form an overlapping staple/tape flap.
3. Install insulation with jacketing outside so staple/tape flap overlaps insulation and jacketing on other end.
4. Butt ends of insulation tightly together.
 - a. Rectangular and Square Ductwork: Do not compress insulation at duct corners.
5. Staple longitudinal and circumferential joints with outward clinching staples minimum 6 inches on center, and seal with pressure sensitive sealing tape.
6. Cut off pretruding ends of fasteners flush with insulation surface and seal with pressure sensitive sealing tape.
7. Install duct insulation fasteners on bottom side of horizontal duct runs, when bottom dimension of the duct is in excess of 24 inches in width.

8. Install duct insulation fasteners on sides of duct risers having a dimension over 24 inches in size.
9. Seal tears, punctures, and penetrations of insulation jacketing with sealing tape and coat with vapor barrier mastic.
10. Secure insulation to ductwork with fasteners spaced in accordance with the following schedule:

DUCT DIMENSION	SPACING OF FASTENERS (MINIMUM)
Up to 24 inches	None required.
24 inches to 48 inches	Horizontal Runs: 2 rows - 16 inches on center. Risers: 16 inches on center, all directions.
49 inches to 60 inches	Horizontal Runs: 3 rows - 16 inches on center. Risers: 16 inches on center, all directions.
61 inches and over	Horizontal Runs: 16 inches on center, all directions. Risers: 16 inches on center, all directions.

- C. Bench Insulated Ductwork:
 1. Insulate ducts prior to erection in place when ducts are required to be installed proximate to walls, ceilings, equipment or other ductwork, which will not permit adequate space for installation of insulation after ducts are installed.
 2. Line interior surfaces of ducts with thermal and acoustic board insulation, when the specified application of exterior insulation is impractical.
 - a. Written permission from the Director must be received, prior to the substitution of lined ducts for exterior insulated ducts.
 - b. Maintain interior cross-sectional areas of ducts, as noted on drawings.
- D. Flexible Elastomeric Foam Insulation on Ductwork Exposed to the Elements, Exterior to a Building:
 1. Apply 2 inch thick flexible elastomeric foam sheet insulation to ductwork with adhesive.
 - a. Insulate sheet metal duct seams, angle bracing, and reinforcing with same insulation thickness specified for ductwork.
 2. Apply reinforcing membrane around ductwork insulation with adhesive or mastic.
 3. Adhesive Applied System: Apply 2 coats of finish. See Section 099103.
 4. Mastic Applied System: Apply another coat of mastic over reinforcing membrane.

3.10 FIELD QUALITY CONTROL

- A. Field Samples: The Director's Representative, may at his discretion, take field samples of installed insulation for the purpose of checking materials and application. Reinsulate sample cut areas.

3.11 PIPING AND EQUIPMENT INSULATION SCHEDULE

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- A. Insulate all cold service and hot service piping, equipment, and appurtenances except where otherwise specified.
- B. Schedule of Items Not to be Insulated:
 - 1. Do not insulate the following cold service items:
 - a. Actual heat transfer surfaces.
 - b. Cold water piping buried in direct contact with ground.
 - c. Chromium plated piping, unless otherwise specified.
 - d. Flexible vibration eliminators.
 - e. Refrigerant liquid piping, unless sub-cooled below 70 degrees F.
 - f. Boiler water treatment equipment and piping.
 - g. Water meters.
 - h. Chemical feed piping.
 - i. Boiler header drains.
 - 2. Do not insulate the following hot service piping:
 - a. Plated or white metal piping.
 - b. Condenser water piping, unless otherwise indicated.
 - c. Exposed risers (hot water, low pressure steam and condensate return) in finished rooms.
 - d. Piping inside convector and finned tube radiation enclosures.
 - e. Short vertical and horizontal piping connections (less than 24 inches in length):
 - 1) Located exposed above floors in finished rooms or finished spaces.
 - 2) Serving one fixture, or one piece of equipment.
 - 3) Connected to horizontal mains, branch mains or riser mains.
 - 4) Conveying liquids or vapors at temperatures from 75 degrees F to 215 degrees F, unless otherwise specified.
 - f. Drains from heating equipment and appurtenances that flow to waste.
 - g. Fuel oil fill, fuel oil vent and other unheated fuel oil piping.
 - h. Gas piping.
 - i. Water and other fluids 81 degrees F to 104 degrees F.
 - j. Branch blow-down piping connections, from continuous blow-down piping to boiler sample water coolers.
 - k. Boiler blow-off and blow-down piping.
 - l. Discharge piping from steam safety and water relief valves.
 - m. Vent piping to atmosphere from installed exposed in Mechanical Equipment Rooms, Steam Service Rooms, Machine Rooms, Boiler Rooms, Penthouses and Power Plants, and connected to the following:
 - 1) Blow-off tanks.
 - 2) Flash tanks.
 - 3) Condensate tanks.
 - 3. Do not insulate the following hot service fittings, valves, flanges and irregular surfaces:
 - a. Flanges and unions in Type E, F and G service piping systems.
 - b. Hydronic Specialties:
 - 1) Flow indicators.
 - 2) Zone control valves.

- 3) Air vents.
- 4) Air control fittings.
- c. Steam traps and cooling legs of steam traps.
- d. Pressure reducing valves and pilot lines.
- e. Safety and relief valves.
- f. Back pressure valves.
- g. Float chambers and level controllers.
- h. Boiler water columns.
- i. Soot blower heads.
- j. Steam turbine drives.
- k. Venturi tubes and orifice plates.
- 4. Do not insulate the following hot service equipment:
 - a. Actual heat transfer surfaces.
 - b. Vacuum pumps and vacuum pump receiving tanks.
 - c. Condensate pumps and condensate pump receivers.
 - d. Hot water pumps.
 - e. Boiler return pumps.
 - f. Fuel oil pumps.
 - g. Chemical feed pumps.
 - h. Condenser water pumps, unless otherwise indicated.
 - i. Fuel oil blow-off tanks, flash tanks, expansion and compression tanks.
 - j. Gas meters and boiler feed water meters.
 - k. Equipment manholes, handholes, and cleanouts.
 - l. ASME stamps, nameplates with manufacturer's name and model number.
- 5. Do not insulate items installed under other Contracts.
- 6. Do not insulate mechanical equipment with a factory applied insulated steel jacket.

3.12 COLD SERVICE INSULATION MATERIAL SCHEDULE

TYPE	SERVICE AND TEMPERATURES	INSULATION MATERIAL	PIPE SIZES (INCHES)	MINIMUM (NOMINAL) INSULATION THICKNESS (INCHES)
A & B	Refrigerants, Brine, and Fluids below 40 F.	Flex. Elastomeric Foam	1 & less	1
			1-1/4 and Up	1-1/2
C	Chilled Water and other fluids (except domestic cold water) 40 F to 80 F.	Flex. Elastomeric Foam or Fibrous Glass	1-1/2 & less	1
			Over 1-1/2	1-1/2
D	Domestic cold water, and as specified. 33 F to 80 F.	Flex. Elastomeric Foam or Fibrous Glass	All Sizes	1/2

A. NOTES:

1. Double the insulation thickness above for piping, installed in tunnels and conduits.
2. Equipment Insulation: Insulation thicknesses above also apply for flat, curved and irregular equipment surfaces.
 - a. Insulate equipment with fibrous glass board insulation with minimum density 6 pcf.
 - b. Insulate base mounted and unitary type pumps and other equipment specified, installed in potable water, ice water, chilled water and dual temperature water systems, with 3/4 inch thick sheet flexible elastomeric foam.
 - c. Exceptions: Minimum insulation thickness for Type A service shall be a minimum of 1 inch thick for flat, curved and equipment irregular surfaces.
3. Type D Insulation Materials: In addition to the services shown on the schedule above, use Type D materials and thicknesses for the following:
 - a. Condensate Drain Piping:
 - 1) Piping connected to drain pans under cooling coils within unit enclosure, except where over drain pans.
 - 2) Horizontal condensate drain piping outside unit enclosures.
 - 3) Vertical condensate drain piping of less than one story immediately following horizontal run.

3.13 HOT SERVICE INSULATION MATERIAL SCHEDULE

	SERVICE AND TEMPERATURES	INSULATION MATERIAL	PIPE SIZES (INCHES)	MINIMUM (NOMINAL) INSULATION THICKNESS (INCHES)
E	Water and other fluids 105 F to 140 F.	Flex. Elastomeric Foam or Fibrous Glass	1-1/2 & Less	1
			Over 1-1/2	2
F	Water and other fluids 141 F to 250 F.	Fibrous Glass	6 & Less	2
			8 & Up	2-1/2
F	Steam (LPS) to 15 psig	Fibrous Glass	1-1/2 & Less	1-1/2
			2 & Up	3

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G	Water and other fluids 251 F to 350 F.	Fibrous Glass	1 & Less	2
			1-1/4 to 4	2-1/2
			5 and Up	3-1/2
G	Steam (MPS) to 16 to 125 psig	Fibrous Glass	1 & less	2
			1-1/4 to 4	3
			5 & Up	3-1/2
H	Water and other fluids Above 350 F.	Fibrous Glass	2 & less	2-1/2
			2-1/2 to 4	3
			5 & Up	3-1/2
H	Steam (HPS) to 126 psig and Above	Fibrous Glass	1-1/2 & less	2-1/2
			2 to 4	3
			5 & Up	3-1/2

A. **NOTES:**

1. Insulate piping in tunnels and conduits with insulation of thickness as follows:
 - a. Types E, F, and G Service: Minimum 2 inch thick unless greater thickness is specified in Hot Service Insulation material Schedule above.
 - b. Type H Service: Minimum 4 inch thickness.
2. Equipment Insulation:
 - a. Insulate the following with fibrous glass block or board insulation:
 - 1) Low pressure steam and heating hot water boilers.
 - 2) Instantaneous type domestic hot water heaters.
 - 3) Combination domestic hot water heater and storage tanks.
 - 4) Domestic hot water storage tanks.
 - 5) Convertors.
 - 6) Heat exchangers.
 - 7) Condensate return tanks.
 - 8) Deaerating feed water heaters.
 - 9) Fuel oil heaters and similar equipment.
 - b. Insulate equipment with fibrous glass board insulation with minimum density 6 pcf.
 - c. Minimum thickness for flat, curved and irregular equipment surfaces:
 - 1) 1-1/2 inch for E and F service.
 - 2) 3 inch for G service.
 - 3) 5 inch for H service.

3.14 SCHEDULE OF METAL JACKETING FOR INSULATED PIPE

- A. Jacket exposed insulated risers with preformed sectional aluminum metal jacketing, in Types E to H service piping systems, installed in finished rooms or finished spaces above Basement Floor Level.
 - 1. Exception: Preformed sectional aluminum metal jacketing is not required on piping in Mechanical Equipment Rooms, Steam Service Rooms, Penthouse, Mechanical Equipment Rooms and Machine Rooms.
- B. Install jacketing from floor to ceiling or from floor to first change of direction in riser, when such change in direction is a minimum of 9'-0" above finished floor, whichever is applicable.
 - 1. The aforementioned also applies to down feed piping systems.
- C. General:
 - 1. Jacket exposed insulated piping in _____ with preformed sectional aluminum metal pipe jacketing.
- D. Piping in Tunnel Manholes: Jacket insulated piping with circumferentially corrugated aluminum jacketing.
 - 1. Lap longitudinal and circumferential joints a minimum of 2 inches.
 - 2. Secure jacketing in place with 1/2 inch x 0.020 inch thick aluminum bands secured with aluminum wing type seals, on maximum 12 inch centers.
 - 3. Jacketing is not required on fittings, valves, flanges, and irregular surfaces.
 - 4. Install jacketing so as to avoid trapping condensation and precipitation.
 - 5. Extend jacketing a minimum of 10 feet inside tunnels in all directions.
- E. Piping Exterior to Building: Jacket insulated piping with circumferentially corrugated aluminum jacketing.
 - 1. Lap longitudinal and circumferential joints a minimum of 2 inches.
 - 2. Secure jacketing in place with 1/2 inch x 0.020 inch thick aluminum bands secured with aluminum wing type seals, on maximum 12 inch centers.
 - 3. Cover insulated fittings, valves, and offsets with mitered sections of jacketing. Seal joints with metal pipe jacket sealant, and secure with aluminum strapping and wing seals.
 - 4. Factory fabricated, preformed fitting covers of same material as jacketing may be used instead of mitered jacketing.
 - 5. Install jacketing so as to avoid trapping condensation and precipitation.

3.15 SMOKE BREECHING AND SMOKE FLUE PIPE INSULATION SCHEDULE

- A. Do not insulate the following smoke breeching and smoke flue piping:
 - 1. Smoke flue pipes 12 inches in size and smaller, connected to low pressure steam and heating hot water boilers, oil or gas fired domestic hot water heaters and incinerators.
 - 2. Factory fabricated insulated smoke flue pipe and smoke stacks.

3. Induced draft fans installed in low pressure steam or heating hot water boiler smoke flue piping or smoke breeching.
- B. Insulate the following with 2 inch thick ASTM C 612 Type V fibrous glass block or board insulation:
 1. Exterior surfaces of smoke flue pipes 13 inch size and larger.
 2. Smoke breeching connected to the following:
 - a. Oil or gas fired low pressure steam boilers.
 - b. Low pressure heating hot water boilers.
 - c. Domestic hot water heaters.
 - d. Incinerators.

3.16 DUCTWORK SERVICE INSULATION SCHEDULE

- A. Insulate all ductwork service except where otherwise specified.
- B. Do not insulate the following ductwork service items:
 1. Exhaust ductwork, unless otherwise shown.
 2. Return fans.
 3. Exhaust fans.
 4. Interior lined ductwork.
 5. Flexible ductwork connections.
 6. Interior lined air terminal units.
 7. Sound absorbers.
 8. Ductwork located within equipment.
 9. Ductwork where design temperature difference between interior and exterior of duct or plenum does not exceed 15 degrees F.

3.17 DUCTWORK SERVICE INSULATION MATERIAL SCHEDULE

LOCATION	SERVICE	INSUL. MATERIAL	MINIMUM INSUL. THICKNESS	JACKET TYPE	MINIMUM REQUIRED R VALUE
Concealed, inside building insul. envelope in unconditioned spaces (in shafts, ceilings, walls, and floors)	Air Conditioning Supply and Returns Under 65 F, 100% Outside Air, Heating Supply Over 85 F.	Fibrous Glass Blanket	2	I or II	R-5
	Returns with Temp. Diff. With Ambient Greater than 15 degrees F	Fibrous Glass Board	1-1/2	I or II	
Exposed, inside building insul. envelope.	Air Conditioning Supply Under 65 F, 100% Outside Air, Heating Supply Over 85 F.	Fibrous Glass Board	1-1/2	I with Canvas Outer Jacket	R-5
Inside building but exposed to outside air temp., e.g., ventilated attic.	Air Conditioning Supply, Heating Supply, All Returns including returns mixed with outside air.	Fibrous Glass Blanket	2-1/2	I or II	R-8
		Fibrous Glass Board	2	I or II	

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LOCATION	SERVICE	INSUL. MATERIAL	MINIMUM INSUL. THICKNESS	JACKET TYPE	MINIMUM REQUIRED R VALUE
Exposed exterior to building.	Air Conditioning Supply, Heating Supply, All Returns including returns mixed with outside air.	Elastomeric Foam Sheet	2-1/2	None Required	R-8

A. **NOTES:**

1. Equipment: Insulate air handling equipment, not furnished with factory applied insulated jacket or internal insulation, with minimum 1-1/2 inch thick fibrous glass board with an ASTM C 1136 Type I jacket, installed and finished as specified for exposed ductwork in finished spaces.

END OF SECTION

SECTION 230900

INSTRUMENTATION AND CONTROL FOR HVAC (GENERAL)

1.1 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including:

1. Direct digital control system components.
2. Temperature transmitters.
3. Thermistors.
4. Static pressure transmitters.
5. Protective thermostats and detectors.
6. Relative humidity transmitters.
7. Thermowells.
8. Resistance temperature detectors.
9. Differential pressure transmitters.
10. Airflow-measuring station.
11. Differential pressure switch.
12. High-temperature room thermostat.
13. Current-sensing relay.
14. Leak detector.
15. Time delay relay.
16. Ultrasonic flow meter.
17. BTU meter.
18. Automatic control valves.
19. Damper actuators.
20. Field equipment cabinets.
21. Electrical wiring and material.

1.2 RELATED DOCUMENTS

- A. Refer to Specifications for the scope of work furnished and installed under those divisions on which work in this division may be dependent.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.3 DEFINITIONS

- | | |
|---------|--|
| A. AHU | Air Handling Unit. |
| B. ATC | Automatic Temperature Control. |
| C. BAS | Building Automation System. |
| D. BMS | Building Management System. |
| E. CFM | Cubic Feet per Minute. |
| F. DCV | Demand Controlled Ventilation |
| G. DDC | Direct-digital controls. |
| H. FAS | Fire Alarm System. |
| I. FCU | Fan Coil Unit. |
| J. HVAC | Heating, Ventilating and Air Conditioning. |

K. I/O	Input/Output.
L. LAN	Local Area network.
M. LCD	Liquid Crystal Display.
N. MER	Mechanical Equipment Room.
O. MS/TP	Master-Slave/Token-Passing.
P. NEMA	National Electric Manufacturers' Association
Q. PID	Proportional Integral Derivative.
R. POT	Portable Operators Terminal.
S. UPS	Uninterruptable Power Supply.
T. VAV	Variable Air Volume.
U. VFD	Variable Frequency Drive.

1.4 SCOPE OF WORK

- A. The BAS/BMS Contractor shall provide a complete and operational system that will perform the sequences of operation as described herein.
 - 1. Provide a new BMS server and workstation located in the Museum Mechanical Room to support the new BMS.
- B. N/A
- C. In addition to the scope listed above, provide allowances for the following:
 - 1. Provide forty (40) hours of programming for any global functionality not explicitly described in the design documents. Any additional time required beyond this allowance shall be billed at the hourly rate.
 - 2. Provide forty (40) hours of troubleshooting/commissioning with the building operations team to understand satisfy global functionality requirements of the BMS. Any additional time required beyond this allowance shall be billed at the hourly rate.
 - 3. Provide eight (8) hours of on-site training for four (4) building operators from competent factory authorized personnel. Intent is to provide instruction to operation and maintenance personnel concerning the location, operation and troubleshooting of the installed systems.

1.5 TECHNICAL PROPOSAL

- A. Each bidder shall provide with his bid a detailed technical proposal describing all elements of the system. A schematic system layout shall be provided, showing relation of these elements and a description of how they operationally interrelate. Technical specification data sheets shall be provided for all proposed system components and devices. The proposal shall be of sufficient detail to ascertain all elements of the system. At a minimum it must include:
 - 1. Hardware specifications for the proposed equipment.
 - 2. Software Specifications for the proposed system.
 - 3. System architecture and general schematic layout.
 - 4. Control point schedule and control strategies.
 - 5. Workstation Computer Software, including graphics, alarming, trending, etc. capabilities.
 - 6. Construction schedule including work anticipated to be performed during overtime.
 - 7. Installation approach and methodology.
 - 8. Guarantees and warranties.

9. Training program.
 10. Service contract.
 11. Unit pricing.
 12. List of spare parts.
- B. This request for proposal includes the following documents for use in preparing the response.
1. Input/output summary.
 2. System architecture.
 3. System specifications.
- C. Each Bidder shall submit a statement of compliance with the specifications and contract documents. This statement shall consist of a list of numbered paragraphs with “C” for Comply, “D” for Deviation, and “E” for Exception listed next to each as described herein. Final determination of compliance with these specifications shall rest solely with the Engineer and Owner who will require proof of prior satisfactory performance. All non-compliance is subject to Owner and engineer approval.
1. Comply “C” – Proposed system or solution complies with the stated function or requirement.
 2. Deviation “D” – Proposed system or solution accomplishes the stated function in a manner different from that described. Provide full description of the deviation.
 3. Exception “E” – Proposed system or solution does not comply with project requirement. Provide full description of exception.
 4. Note: where a description of a deviation is not provided, it shall be assumed that the submitted proposal complies with the specifications.
- D. Each Bidder shall submit qualifications of the proposed project team that is to be involved with the supervision, the engineering and the installation of the BMS with base bid. Each team member resume shall include information about the training and project experience of each individual. Resumes for the following team members shall be provided, at a minimum:
1. Principal sales engineer.
 2. Project manager.
 3. Local branch manager.
 4. Project engineer.
 5. Application engineering staff and the electronic technicians.
- E. Each Bidder shall submit information on the following corporate/product qualifications, at a minimum:
1. Number of years in the BMS business (minimum 10 years required).
 2. Number of years the proposed system has been manufactured.
 3. A written guarantee for the number of years that the proposed system shall be the standard product offering, with parts availability and factory-trained field-support.
 4. A summary of the system product line, with field panels, workstations, etc. including a plan for backwards compatibility and non-obsolescence.
 5. Description of quality assurance procedures – both hardware and software.
 6. Summary of recent projects of similar size and complexity to this project in which the proposed system has been installed.

- F. Each Bidder shall submit course catalog descriptions and content that can be used for operator, programmer, and service training of the proposed system.
- G. The Bidder is required to identify and submit in their bid proposal any discrepancies that may exist between the bid documents and plans and specifications. Any discrepancies that are not identified for resolution by the Owner prior to the issuance of this subcontract will be the sole responsibility of the Bidder.
- H. The Bidder may propose voluntary alternates to this specification. All voluntary alternates must be expressed as line item Adds or Deducts to the Base Bid. Alternates shall include all materials and labor necessary to provide a fully operational system as specified.

1.6 SUBMITTALS

A. Submittals shall include the following:

1. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials and installation and startup instructions for each type of product indicated.
 - a. Each control device labeled with setting or adjustable range of control.
 - b. DDC System Hardware: Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels and operator interface equipment.
 - c. Control System Software: Include technical data for operating system software, operator interface, color graphics and other third-party applications.
 - d. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number and product data. Include written description of sequence of operation including schematic diagram.
2. Schedule and specification sheets for control damper actuators, including material and construction details, duct size, damper size, actuator mounting location, and quantity of actuators.
3. Schedule of automatic control valves and motorized isolation valves with specification sheets for each valve. At a minimum, the schedule shall list body pressure rating, close-off pressure rating, Cv factor, pressure drop at specified capacity, rangeability, and valve flow characteristics. Valves shall be sized based on approved equipment shop drawings, not mechanical schedules.
4. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection. Submittal shall include the following as a minimum:
 - a. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, instrumentation and control devices.
 - b. Wiring Diagrams: Power, signal and control wiring.
 - c. System architecture drawing including all communication wiring, network devices, etc. Indicate type of cabling and number of conductors.
 - d. Symbol and abbreviation list for control diagrams.

- e. Points list including hardwired and software points.
 - f. Manufacturer's technical cut sheets which include a table of contents and an associated sheet numbering system for all pages. Model number shall be circled or pointed with an arrow.
 - g. A complete bill of materials specific to each system detailing the equipment to be used, quantity, manufacturer, specific model number and tag number.
 - h. List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule and operator notations.
 - i. Details of control panel faces, including controls, instruments and labeling.
- 5. For each BACnet device, submit a PICS document showing the installed device's compliance level.
 - 6. For each Modbus device, submit details for communication parameters and all published point registers available for each unique device.
 - 7. Architectural floor plans indicating proposed locations of all wall-mounted devices (i.e., DDC units, control panels, sensors, thermostats, etc.) and mechanical drawings indicating proposed locations of all temperature, flow and pressure transmitters.
 - a. Submit samples of all wall-mounted devices located in occupied spaces. Devices include thermostats, temperature sensors, humidity sensors, CO2 sensors, etc.
 - 8. Mechanical sheet metal shop drawings indicating proposed locations of all static pressure transmitter locations.
 - 9. Mechanical piping shop drawings indicating proposed locations of all temperature, flow and pressure transmitters.
 - 10. All submittals used by field personnel for the installation of equipment shall bear an Engineer's approval stamp.

1.7 OPERATIONS AND MAINTENANCE DATA

- A. Submit three (3) copies of record (as-built) documents upon completion of installation. Submittal shall consist of:
 - 1. As-built versions of the submittal shop drawings provided in electronic format and as 11 x 17-inch prints.
 - 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements in the Control System Demonstration and Acceptance section of this specification.
 - 3. Operation and Maintenance (O & M) Manual.
 - a. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:
 - 1. Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.

2. Description of manual override operation of all control points in system.
3. BMS system manufacturers complete operating manuals.

1.8 QUALITY ASSURANCE

A. All work associated with this system shall comply with the following codes:

1. National Electric Code.
2. National Fire Protection Associated (NFPA) Codes.
3. Local and national building codes.
4. Local and national energy conservations codes.
5. Owner's requirements.

B. Qualifications

1. Wherever possible, furnish all equipment of any equipment type (such as damper actuators, valves, relays, etc.) from one (1) manufacturer.
2. The drawings show the various piping and duct systems schematically. No added compensation shall be permitted for variations due to field conditions.
3. Installing contractor shall be in the business of installing and servicing DDC controls for mechanical systems, temperature and ventilation control, environmental control, lighting control, access and security, life safety and energy management as their primary business.
4. Installer Qualifications: An experienced installer who is the authorized representative of the automatic control system manufacturer for both installation and maintenance of controls required for this Project.
5. Engineering, drafting, programming, and graphics generation shall be performed by engineers and technicians employed by the Building Automation System Contractor.
6. Supervision, checkout and commissioning of the system shall be by the local branch engineers and technicians directly employed by the Building Automation System Contractor. They shall perform commissioning and complete testing of the BAS system.
7. The system shall have a documented history of compatibility by design for a minimum of fifteen (15) years. Future compatibility shall be supported for no less than ten (10) years. Compatibility shall be defined as the ability for any existing control system component including but not limited to primary control panels, secondary control panels, personal operator workstations and portable operator's terminals, to be connected and directly communicate with any new BMS system equipment without bridges, routers, or protocol converters.

1.9 JOBSITE CONDITIONS

A. Inspection of Site Conditions

1. Prior to submission of bid, visit the site and examine the conditions under which the work has to be performed. Report in writing any inquiries or conditions which might adversely affect the work.

B. Connections to Existing Work

1. The installation of the systems, equipment and related components, under this contract

must be installed in sequence and phased as described in the specifications. It is the intention of the project team to minimize the number and duration of all shut downs and disruptions to the facility. Therefore, it is necessary for the contractor to thoroughly familiarize himself with all intermediate steps and phases of this project and the final system configuration.

2. Install new work and connect to existing work with minimum interference to existing facilities.
3. Provide temporary shutdown of existing services at no additional charges and only with written consent of Owner. Schedule shutdowns not to interfere with normal operation of existing facilities.
4. Maintain continuous operation of existing facilities as required with necessary temporary connections between new and existing work.
5. Connect new work to existing work in neat and acceptable manner. Restore existing disturbed work to original condition.
6. Refer to Owner for work to be performed only after regular working hours.

C. Removal and Relocation of Existing Work

1. Disconnect, remove, or relocate existing BMS equipment and other work noted and required by alterations, modifications, or changes in existing construction.
2. Provide new material and equipment as required to relocate equipment and related system components.
3. Dispose of removed BMS equipment and system components as directed. Return removed BMS equipment and system components to Owner as directed.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.
- B. Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storing, and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather. The stored products shall be protected from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.
- C. System Software: Update to latest version of software at project completion.

1.11 PROJECT PHASING

- A. The existing BMS system and front end shall stay online and usable as long as there is equipment connected to it.
- B. When the building is vacated, (for 1 year) and the asbestos abatement is completed, the existing BMS may be removed for relocation. The installation of the new BMS serving this facility will be coordinated with the other trades.

1.12 COORDINATION

- A. Coordinate location of temperature sensors, humidity sensors and other exposed control sensors with plans and room details before installation.
- B. Coordinate installation of taps, valves, airflow stations, etc. with the mechanical contractor.
- C. Coordinate BMS equipment with all relevant divisions including, but not limited to, Fire Alarm to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate BMS equipment to achieve compatibility with motor starters and annunciation devices.
- E. Coordinate IP drops, network connections, user interfaces, firewall, etc. with Owner's IT representative.
- F. Coordinate routing of network communication cabling with associated trades.
- G. Coordinate power for control units and operator workstation with electrical contractor.

1.13 WARRANTY

- A. Warranty the direct digital control system to be free from defects in workmanship and material for a period of one (1) year from completion of final commissioning. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of twelve (12) months from completion of system demonstration.
- B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be twenty-four (24) hours.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. The BMS contractor shall be an independent contractor not affiliated with the mechanical contractor. Only the NY/NJ branch offices of the controls system manufacturer shall be acceptable. Associated control dealers and VAPS (despite the product line) shall not be eligible to bid on this project.
- B. Basis of Design
 - 1. Carrier (I-VUE+)
- C. Alternate Vendors
 - 1. Honeywell International Inc. Factory Branch Office NY/NJ
 - 2. Johnson Controls Factory Branch Office NY/NJ

2.2 SYSTEM DESCRIPTION

- A. The BMS shall consist of a network of standalone microprocessor-based direct digital control units (DDCs). Each direct digital control unit shall perform all specified control and monitoring functions independently. Failure of one (1) control unit shall have no effect upon

- any other unit in the network. The direct digital control units shall communicate with each other and the servers and workstations. The BMS shall include a full graphic software and graphical operator interface.
- B. System input/output point capacity shall be expandable by the addition of DDC units and unitary controllers to the communications network.
 - C. The operator, through any workstation, shall have the ability to monitor DDC application and sensor data, override set points and schedules, set and reset control points and download programs to the local direct digital control units. A server and workstation network requiring database changes to be made at more than one (1) location shall not be acceptable.
 - D. Communication protocol between server, workstations, DDC and unitary controllers shall utilize ASHRAE Standard 135 BACnet. In addition, the DDC system shall be capable of providing industry-standard open-protocol communication (BACnet, Modbus, OPC, SOAP, SNMP, XML) to other equipment and/or building systems.
 - E. The direct digital control units shall be UL 916 (Energy Management Equipment) listed.
 - F. Communication between the workstations and server shall be by way of a high-speed communications cable utilizing Ethernet technology. The DDC units shall also communicate directly to the server utilizing Ethernet technology.
 - G. DDC units serving air handling units shall communicate via BACnet/SC. Provide one (1) DDC unit per system unless otherwise specified.
 - H. Unitary controllers serving VAVs, FCUs, etc. shall communicate via BACnet/SC. Unitary controllers utilizing BACnet MS/TP communication shall NOT be acceptable. Provide one (1) unitary controller per terminal unit unless otherwise specified.
 - I. The furnished BMS shall be complete in all respects so that it shall perform its specified functions in accordance with this section of the specifications. Implementation of all control functions shall be the responsibility of the BMS provider.
 - J. The entire BMS shall be complete with all necessary control devices, thermostats, valves, motors, relays, switches, dampers, panel, and electric wiring to provide the functions as described hereinafter, regardless of whether or not they are specifically mentioned.
 - K. The BMS shall be installed complete in all respects by competent personnel, factory-trained by the manufacturer of the control system. All automatic control valves and dampers shall be installed in pipelines and ducts by the respective trade under supervision of the control system provider
 - L. All point names, equipment names, equipment labeling, etc., must comply with Owner's equipment naming convention. The vendor is responsible for coordinating with the Owner to determine standards and providing their implementation.
 - M. All workstation graphics must comply with Owner's standard. The vendor is responsible for coordinating with the Owner to determine standards and providing their implementation.
 - N. Workstation advisory messages, printouts, logging, alarm formats, etc., must follow Owner's standards.
 - O. All software provided for this project shall include manufacturer's certificate and shall be original software purchased for this project. All third-party software shall also be the original software.

2.3 SYSTEM FUNCTIONS AND PERFORMANCE

- A. The BMS shall be capable of accepting inputs (analog, digital, pulsed digital, thermistor, and RTD) from field devices, and of producing analog and digital outputs (4 - 20 mA DC, pulse width modulation, and 0-10 VDC) for control and monitoring functions in order to:

1. Adjust control parameters for process-controlled variables.
 2. Initiate, define and acknowledge audible alarms.
 3. Start/stop motors and position valves and dampers.
 4. Initiate shutdowns due to activation of safety devices.
 5. Communicate with the servers and workstations.
- B. Comply with the following response times and performance requirements:
1. Graphic Display: Display graphic with minimum 20 dynamic points with current dynamic data within 15 seconds.
 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current dynamic data within 8 seconds.
 3. Object Command: Reaction time of less than two seconds between operator command or binary object status alarm and device reaction.
 4. Object Scan: Transmit change of state and change of analog values to control units (DDC panels) or workstation within six seconds.
 5. Alarm Response Time: Annunciate alarm at workstation within 30 seconds. Multiple workstations must receive alarms within 5 seconds of each other.
 6. Program Execution Frequency: Run capability of applications as often as 5 seconds, but selected consistent with mechanical process under control.
 7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
 8. Reporting Accuracy and Stability of Control:
 - a. Water Temperature: $\pm 0.5^{\circ}\text{F}$
 - b. Water Flow: $\pm 5\%$ of full scale
 - c. Water Pressure: $\pm 2\%$ of full scale
 - d. Space Temperature: $\pm 0.5^{\circ}\text{F}$
 - e. Ducted Air Temperature: ± 0.5
 - f. Outside Air Temperature: $\pm 2^{\circ}\text{F}$
 - g. Dew Point Temperature: $\pm 1.5^{\circ}\text{F}$
 - h. Temperature Differential: $\pm 0.15^{\circ}\text{F}$
 - i. Relative Humidity: $\pm 5\%\text{RH}$
 - j. Airflow (Pressurized Spaces): $\pm 3\%$ of full scale
 - k. Airflow (Measuring Stations): $\pm 5\%$ of full scale
 - l. Airflow (Terminal): $\pm 10\%$ of full scale
 - m. Air Pressure (Space): ± 0.05 inches of water
 - n. Air Pressure (Ducts): ± 0.25 inches of water
 - o. Carbon Monoxide: $\pm 5\%$ of reading
 - p. Carbon Dioxide: ± 25 ppm
 - q. Electrical: $\pm 5\%$ of reading

2.4 SYSTEM ARCHITECTURE

- A. The system architecture shall consist of a network of independent, standalone BACnet IP based primary controllers and BACnet IP based unitary controllers. Each controller shall perform all specified control and monitoring functions independently. Failure of one (1) control unit shall have no effect upon any other unit in the network.
- B. The system architecture shall be based on a modular PC network, utilizing industry standard

operating systems, networks and protocols.

- C. The system shall allow the distribution of system functions such as monitoring and control and graphical user interface etc. across the network to achieve maximum flexibility and performance.
 - D. Data communications protocol shall be BACnet and shall comply with ASHRAE 135.
 - E. Each DDC, unitary controller, server, and workstation shall communicate via TCP/IP over Ethernet.
 - F. Use fiber optic cabling for all Ethernet runs longer than 300 ft.
 - G. The BMS shall utilize the existing Owner's network. This Contractor shall be responsible for coordinating network drop quantities and locations with the Owner.
 - H. The BMS and its controllers shall be native-BACnet/SC or shall be BACnet/SC-ready by future firmware upgrade to provide data encryption utilizing secure Websocket protocol with TLS V1.3 (WSS) functioning on TCP/IP.
-
- 1. System controllers shall be native-BACnet/SC or shall be BACnet/SC-ready by future firmware upgrade to provide device authentication of those BACnet/SC devices by utilizing the X.509 International Telecommunication Union standard defining the format of PKI certificates.
 - 2. System controllers shall utilize two (2) BACnet/SC hubs per BACnet network for logical function. A primary hub is required for communication to occur on the BACnet/SC network. A secondary failover hub shall be required to ensure communication can resume in the case of primary hub failure.
 - a. BACnet/SC hubs shall be embedded devices on the BACnet/SC network.
 - b. BACnet/SC hub-capable controllers shall support routing between different BACnet data link types such as BACnet/SC-to-BACnet/IP routing.
 - c. BACnet/SC controllers with BACnet/SC hub functionality must support a minimum of 100 node connections per hub.
 - 3. System controllers shall support BACnet/SC node, or BACnet/SC hub+node functionality (natively or with future firmware upgrade) for the system to function.
 - 4. BACnet/SC must support Certificate Authority (CA) and Certificate Management
 - a. BAS provider must provide software tools for Certificate Authority and Certificate Management.
 - b. The software tool must be made available to interact with the customer's IT department infrastructure by exchanging certificates and CSR (certificate signing request) for certificate management of the BACnet/SC system for the life of the building automation system.
 - c. The BACnet/SC solution must allow for an internal-to-the-organization Certificate Authority (self-signed certificates) utilizing a software tool method capable of generating, signing, and provisioning certificates to the BAS vendor's devices, and revoking certificates completely on its own.
 - d. The BACnet/SC Certificate Management must allow for interaction with a trusted 3rd party Certificate Authority (CA) for customers. The BAS vendor provided software tool for generating certificates and provisioning them to the vendor's devices must be able to generate a CSR (Certificate Signing Request)

and be able to export the required common Root Certificate (aka Issuer Certificate) on a file level to be signed by a trusted 3rd party certificate authority of the customer's preference as well as be able to import the signed certificate and provision it to the vendor's devices along with the required unique Operational Certificates (aka Client Certificates).

- e. Certificate Management must allow for interoperability with 3rd party vendor BACnet/SC certificate management methods and allow for CA migration (CA1 -> CA2).
 - f. The certificates validity period shall be configurable in the vendor's certificate management tool to comply with customer security requirements. This shall be configurable for a minimum of 1 week or years to a maximum of 25 years.
 - g. The vendor specific BACnet/SC configuration and management tool from each and every BACnet/SC vendor on the project as well as the corresponding project database containing the Root Certificate must be provided to the customer for ongoing certificate management as well as vendor coordination on the project.
- I. Remote Communications: Provide a TCP/IP compatible communication port for connection to the Owner's network for remote communications. Provide coordination with the Owner for addressing and router configuration on both ends of the remote network.
 - J. Provide one (1) new server located in the Support Building Cellar.
 - K. Provide one (1) new workstation located Support Building Cellar.
 - L. Refer to system architecture drawing for additional information.

2.5 BUILDING AUTOMATION SYSTEM NETWORK

- A. The design of the BMS shall network the BMS server, operator workstations, primary control panels and secondary control panels. The network architecture shall consist of multiple network levels. Provide a peer-to-peer Primary Network to connect the existing server, operator workstation(s) and all primary control panels in the building for global system operation. Provide secondary networks to connect from each primary control panel to the secondary control panels of associated terminal equipment.
- B. All networked control products provided for this project shall be comprised of an industry standard open protocol internetwork. Communication involving control components (i.e. all types of controllers and operator interfaces) shall conform to the ASHRAE 135 - BACnet standard. Networks and protocols proprietary to one company or distributed by one company are prohibited.
- C. Controllers and software shall be BTL listed at the time of installation.
- D. Primary control panels may be connected to the primary network via routers if this follows the standard architecture of a specified manufacturer. Provide additional controllers if required according to manufacturer's standard architecture layout to achieve network functionality. Quantity and locations of routers, network controllers, and supervisory controllers to be coordinated with Engineer.
- E. Access to system data shall not be restricted by the hardware configuration of the BMS. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.
- F. The BMS design shall allow the co-existence of current and future primary control panels and personal computer operator workstations on the same primary network.

- G. The BMS contractor shall provide new supervisory controllers/routers as required to connect to all new controllers being installed as part of this project, while still keeping with all requirements such as spare capacity requirements, etc.
- H. The network shall not be utilized to send data required by a control algorithm from one controller to another. The data shall be a direct input to the controller containing the control algorithm. If multiple controllers require the same piece of data for a control algorithm, the data shall be an input to each controller.

2.6 DIN-RAIL MOUNTED BUILDING MANAGED NETWORK SWITCH REQUIREMENTS

- A. Managed network switches shall be DIN-rail mounted and installed within an enclosure furnished by this Contractor. Enclosure shall be NEMA rated for associated space. Provide all required installation kits, enclosure heaters, power supplies, and software.
- B. Each switch shall be installed with 25% of installed spare port capacity. Each spare port shall have a protective cover.
- C. Each network switch shall consist of the following, at a minimum:
 - 1. 10/100/1000BaseT(X) Gigabit Ethernet ports.
 - 2. 100/1000Base SFP Slots (fiber connections).
 - 3. Temperature Range: -10 to 60°C (14 to 140°F).
- D. Provide thirty (30) minute rated DIN-rail mounted UPS.
- E. Provide MOXA EDS-G516E Series, or equivalent.

2.7 SERVER REQUIREMENTS

- A. Provide one (1) new rack-mounted server. Intent is to install server within an IT rack provided by others.
- B. Each server shall consist of the following, at a minimum:
 - 1. Minimum thirty-two (32) GB RAM
 - 2. Two (2) 500 GB SSD in RAID 1
 - 3. Server-grade processor shall have a minimum speed of 3.0 GHz with no less than 4 cores
 - 4. Mouse and 101-key enhanced keyboard.
- C. Provide LCD monitor and keyboard with integrated touchpad which shall occupy one (1) rack space.
- D. Provide thirty (30) minute rated rack-mounted UPS.
- E. Locate the Operator Workstations in a clean, secure, dry and temperature-controlled environment
- F. Provide software licenses for interfacing to the BAS. Load software, configure and setup for viewing the BAS system.
- G. Provide the server with an operating system, such as Windows Server 2016/2019 or other operating systems compatible with the BAS software.
- H. Software: Provide the following application software licenses, preloaded on the workstation for the Owner: MS Office Professional, Internet Explorer or equal browser, MS Outlook, Acrobat Reader, CAD Viewer, Antivirus. Set up an icon on the desktop to take the Owner directly to the BAS system login page.

2.8 OPERATOR WORKSTATION HARDWARE

- A. Provide one (1) new operator workstation. Operator workstation shall be located with the Engineer's Office in the Support Building Cellar.
- B. Workstation shall be provided for command entry, information management, network alarm management and database management functions. All real time control functions shall be resident in the DDC Controllers to facilitate greater fault tolerance and reliability.
- C. Each workstation shall consist of the following, at a minimum:
 - 1. Minimum sixteen (16) GB RAM
 - 2. One (1) 500 GB SSD
 - 3. Processor shall have a minimum speed of 3.0 GHz with no less than 4 cores
 - 4. Mouse and 101-key enhanced keyboard.
- D. Provide a monitor of flat panel type and shall support a minimum display resolution of no less than 1920 x 1080 pixels. The display shall have a minimum of 27-inch visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.
- E. Locate the Operator Workstations in a clean, secure, dry and temperature-controlled environment
- F. Provide thirty (30) minute rated UPS.
- G. Provide software licenses for interfacing to the BAS. Load software, configure and setup for viewing the BAS system.
- H. Provide the PC with an operating system, such as Windows 10 Pro or Windows Server 2016/2019 or other operating systems compatible with the BAS software.
- I. Software: Provide the following application software licenses, preloaded on the workstation for the Owner: MS Office Professional, Internet Explorer or equal browser, MS Outlook, Acrobat Reader, CAD Viewer, Antivirus. Set up an icon on the desktop to take the Owner directly to the BAS system login page.

2.9 BUILDING MANAGEMENT SYSTEM SOFTWARE

A. General

- 1. Provide software which includes the following:
 - a. Scheduling and override of building operations.
 - b. Collection and analysis of historical data.
 - c. Editing, programming, storage and downloading of controller databases, programs and parameters.
 - d. The latest version Microsoft Windows environment that allows the user to run several applications simultaneously. Other Windows applications shall run simultaneously with the BMS software including, but not limited to, Word, Excel, Access, etc.
 - e. Provide a user interface that shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection.
 - f. The operator shall be able to drag and drop information between applications (e.g., click on a point in the alarm screen and drag it into the dynamic trend graph screen to initiate a dynamic trend).
 - g. Operator specific password access protection shall allow the user to limit workstation control, display and data base manipulation capabilities

for each object in the system. An object shall be defined as any input or output point, setpoint, system program, etc. The operator privileges shall “follow” the operator to any workstation or primary control panel that the operator logs on to. Provide a minimum of 1000 passwords.

- h. Operators will be able to perform only those commands on the objects available based on their respective passwords. Menu selections displayed shall be limited to only those items defined for the access level of the password used to log-on.
- i. An audit trail report to track system object changes that shall record operator initiated actions. These actions shall include, but not be limited to, changes made by a particular person, changes made to a specific piece of equipment and/or changes made during a designated time frame. The changes shall be printed and archived for future reference either on command or automatically, at the operator’s option. The operator activity tracking data shall be stored in a tamper proof buffer.
- j. Software shall allow the operator to perform commands including, but not limited to:
 - i. Start up and shutdown of equipment.
 - ii. Setpoint adjustment.
 - iii. Add/modify/delete time programming.
 - iv. Enable/disable process execution.
 - v. Lock/unlock alarm reporting.
 - vi. Enable/disable totalization and/or trending.
 - vii. Override PID loop setpoints.
 - viii. Enter temporary override schedules.
 - ix. Define holiday schedules.
 - x. Change time/date.
 - xi. Automatic daylight savings time adjustments.
 - xii. Enter/modify analog warning and alarm limits.

2. Reporting

- a. Reports shall be generated and directed to displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:
 - i. A general listing of all points in the network.
 - ii. List of all points currently in alarm.
 - iii. List of all points currently in override status.
 - iv. List of all disabled points.
 - v. List of all points currently locked out.
 - vi. DDC Controller trend overflow warning.
 - vii. List all weekly schedules.

3. Scheduling

- a. Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Provide schedules for 365 days in advance.

- b. Weekly schedules shall be provided for each building zone or piece of equipment with a specific occupancy schedule. Temporary overrides and associated times may be inserted into blocks for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.
- c. Zone schedules shall be provided for each building zone as previously described. Each schedule shall include all points that can be commanded residing within the zone. Each point may have a unique schedule of operation relative to the zone's occupancy schedule, allowing for sequential starting and control of equipment within the zone. Scheduling and rescheduling of points may be accomplished easily via the zone schedule graphic.

4. Password

- a. Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display, and database manipulation capabilities as he or she deems appropriate for each user, based on an assigned password.
- b. Each user shall have the following: a user name (12 characters minimum); a password (12 characters minimum), and an access level (from 1 - 5). The system shall allow each user to change his or her password at will.
- c. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
- d. A minimum of five levels of access shall be supported as follows.
 - i. Level 1 = Data Access and Display
 - ii. Level 2 = Level 1 and Operator Overrides
 - iii. Level 3 = Level 2 and Database Modification
 - iv. Level 4 = Level 3 and Database Generation
 - v. Level 5 = All privileges, including Password Add/Modify
- e. A minimum of 100 unique passwords, including user initials, shall be supported.
- f. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
- g. The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.
- h. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving the operator workstation logged on.

5. Collection and Analysis of Historical Data

- a. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or changes of value, both of which shall be user-definable. Trend data shall be stored on hard disk for future diagnostics and reporting.
 - b. Trend data report graphics shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at least 6 points. Provide additional functionality to allow any trended data to be transferred directly to an off-the-shelf spreadsheet package such as Excel. This shall allow the user to perform custom calculations such as energy usage, equipment efficiency and energy costs and shall allow for generation of these reports on high-quality plots, graphs and charts.
 - c. Provide additional functionality that allows the user to view trended data on trend graph displays. Displays shall be actual plots of both historical and/or real-time dynamic point data. A minimum of 10 points shall be viewed simultaneously on a single graph. The user may pause the graph and take "snapshots" of screens to be stored on the hard disk for future recall and analysis. Displays shall include an 'X' axis indicating elapsed time and a 'Y' axis indicating a range scale in engineering units for each point. The 'Y' axis shall have the ability to be manually or automatically scaled at the user's option. Different ranges for each point may be used with minimum and maximum values listed at the bottom and top of the 'Y' axis. All 'Y' axis data shall be color-coded to match the line color for the corresponding point.
 - d. Static graphs shall represent actual point data that has been trended and stored on disk. Exact point values may be viewed on a data window by pointing or scrolling to the place of interest along the graph. Provide capability to print any graph on the system printer for use as a building management and diagnostics tool.
 - e. Dynamic graphs shall represent real-time point data. Any point or group of points may be graphed, regardless of whether they have been predefined for trending. The graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis. As with static graphs, exact point values may be viewed and the graphs may be printed.
6. Dynamic Color Graphic Displays
- a. All workstation(s) shall be provided with color graphics. All workstation(s) software shall include a graphical viewing and control environment and definition and construction of dynamic color graphic displays.
 - b. Provide system color graphics for each HVAC system and for each electrical, plumbing and/or piping system that is monitored and/or controlled by the BMS. Provide scaled floor plans indicating equipment location, service and system data as required.
 - c. Provide color graphic floor plan displays and system schematics for each piece of mechanical equipment, including but not limited to air handling units, chilled water systems and hot water systems to optimize system performance analysis and speed alarm recognition.

- d. Provide links on each graphic to PDF files of the associated sequence of operation, flow diagram, and wiring diagram.
- e. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.
- f. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.
- g. The windowing environment of the PC operator workstation(s) shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
- h. Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays via an off the shelf graphics package.
- i. Provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical symbols.
- j. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points that aids the operator in the analysis of the facility.
- k. Graphical displays shall contain animation to assist the operator in determining status of the equipment being displayed (e.g., a fan that is energized shall rotate).
- l. Provide an automatically updated, dynamic display of the site-specific BMS architecture indicating the status of primary and secondary controllers, PC workstation(s) and networks.
- m. Provide a separate dynamic display page of each HVAC (AHU, AC, chiller, cooling tower, fuel oil, etc.), electrical and/or plumbing system connected to the BMS.
- n. Provide a separate dynamic display page of each piece of terminal equipment (VAV box, fan coil unit, etc.) connected to the BMS.
- o. Provide a separate dynamic display page for each floor or zone. At a minimum, each page shall display the associated space temperature readings and links to equipment located on the floor or in the zone.
- p. Provide an additional (10) separate dynamic, graphic display pages at each workstation as required by the operating staff to further assist in daily system operations.
- q. Graphics shall incorporate all system integration points communicated via hardware or software gateways and/or interfaces. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.

7. System Configuration and Definition

- a. All temperature and equipment control strategies and

energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

- b. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently add, delete or modify any system object including primary control panel(s), operator workstations(s), secondary control panels, reporting definitions, control loops, energy management applications, time and calendar-based programming, totalization, historical data trending, custom control processes, graphic displays, operator passwords, alarm messages, etc.
- c. Definition of operator device characteristics for individual points, applications and control sequences shall be performed using instructive prompting software.
- d. Programming shall be performed with the BMS system online and shall not interfere with BMS system operation.
- e. Inputs and outputs for any process shall not be restricted to a single primary control panel, but shall be able to include data from any and all other network panels to allow the development of network-wide control strategies. Processes shall also allow the operator to use the results of 1 process as the input to any number of other processes (cascading).
- f. Provide the capability to backup and store all system databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation(s) are on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate primary control panel. Similarly, changes made at the primary control panels shall be automatically uploaded to the workstation, ensuring system continuity. The user shall also have the option to selectively download changes as desired.
- g. Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

8. Event Management

- a. Event Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each event: name, value, event time and date, event status, priority, acknowledgement information, and alarm count.
- b. Only events for which the logged on user has privileges to view shall be displayed on each workstation.
- c. The software shall provide the ability to users to limit the list of events displayed at each workstation (e.g. only show fire events at this workstation, no matter who is logged on)
- d. Each event shall have the ability to sound an audible notification based on the category of the event.
- e. Event List shall have the ability to list and sort the events based on event status, point name, ascending or descending activation time.
- f. Directly from the Event List, the user shall have the ability to acknowledge, silence the event sound, print, or erase each event.
- g. The interface shall provide the option to inhibit the

erasing of active acknowledged events, until they have returned to normal status.

- h. The user shall have the ability to navigate to all information related to a selected point in order to command, launch an associated graphic or trended graphical plot, or run a report on a selected point directly from the Event List.
- i. Each event shall have a direct link from the Event List to further user-defined point informational data.
- j. The user shall have the ability to also associate real-time electronic annotations or notes to each event.
- k. Software shall provide the option to configure detailed operating procedures that guide a user through predetermined standard operating procedures for handling critical events. Users shall be able to log completion of each operating step as it is performed.

9. Remote Notification (RENO)

- a. Workstations shall be configured to send out messages to numeric pagers, alphanumeric pagers, SMS (Simple Messaging Service, text messaging) Devices, and email accounts based on a point's alarm condition.
- b. Email notification must support POP3, IMAP, and SMTP with SSL/TSL
- c. Communication with external software must be encrypted.
- d. There shall be no limit to the number of points that can be configured for remote notification of alarm conditions and no limit on the number of remote devices which can receive messages from the system.
- e. On a per point basis, system shall be configurable to send messages to an individual or group and shall be configurable to send different messages to different remote devices based on alarm message priority level.
- f. System must be configurable to send messages to an escalation list so that if the first device does not respond, the message is sent on to the next device after a configurable time has elapsed.
- g. Workstation shall have the ability to send manual messages allowing an operator to type in a message to be sent immediately.
- h. Workstation shall have a feature to send a heartbeat message to periodically notify users that they have communication with the system.

10. External Data Access

- a. The software shall provide the ability to expose configuration properties and real-time values through CSV files, OPC DA, OPC UA, or REST-based Web Services.
- b. The software shall provide the ability for external applications to change configuration and real-time values through OPC DA, OPC UA, or REST-based Web Services.
- c. The software shall provide the ability for external applications to access historical Trend data through CSV files or REST-based Web Services.
- d. External data access must be secured using the level of

- permissions configured for users and operator workstations.
- e. Web service interfaces must allow for exchanging data (object's values, events and trend series) between workstation and external applications such as facility management systems, enterprise applications, mobile applications or other value-added services.
- f. Documentation describing web services interfaces must be included to allow external developers to write applications that leverage the data exchange.

11. Data Security

- a. The BAS software must allow that all communication paths between clients and the server are encrypted and protected against replay attacks as well as data manipulation.
- b. Any runtime data transfer between the system server and Web Server (IIS) must be allowed to be encrypted by Desigo CC.
- c. Communication between any Web Server (IIS) and the Web Clients must be allowed to be encrypted.
- d. Passwords must be handled with encrypted storage and transmission
- e. The software must support the use of public domain algorithms for cryptographic functions, including AES, DiffieHellmann, RSA, and SHA-2. No self-coded algorithms shall be allowed.
- f. All symmetrical encryption must use 256 bit AES or stronger.
- g. All asymmetrical encryption must use 2048 bit or stronger.
- h. The software must support the use of commercial certificates for securing client-server communications.
- i. The software must support the use of self-signed certificates to allow local deployments without the overhead of obtaining commercial certificates.
- j. When using self-signed certificates, the owner of the Desigo CC system is responsible for maintaining their validity status, and for manually adding them to and removing them from the list of trusted certificates.
- k. The BAS software shall be compatible with the following Virus Scanners:
 - i. Kaspersky
 - ii. Avira
 - iii. McAfee
 - iv. Bitdefender
 - v. TrendMicro Office Scan

2.10 WEB-BASED OPERATOR INTERFACE

- A. Provide a Web-Based graphical interface that allows users to access the BMS data via the Internet, extranet, or Intranet (TCP/IP). The Web-Based graphical interface shall use HTML-Based pages to send and receive data directly from a network of BMS Field Panels to a Web

- browser.
- B. The web server shall support browser access via Google Chrome, Firefox, or any browser that supports the compatible plug-in.
 - C. The web server shall not require downloaded apps for support access of handheld, web enabled devices.
 - D. The Web server shall allow monitor and control of data in any field panels networked together on the same automation level TCP/IP Ethernet network.
 - 1. The Web server must provide a common alarm display that shows alarms in all field panels on the network.
 - 2. The Web server must be able to provide common graphics that simultaneously display the current value and status for points residing in multiple field panels.
 - 3. The Web server must be able to display daily mode schedules for points from multiple field panels simultaneously.
 - E. Access to the Web interface shall be username and password protected. A user's rights and privileges to database objects within the BMS shall be configurable on a per-user basis. An option shall exist to only allow users "read" access to BMS objects via the Web browser. Operator sessions shall be configurable for "auto-logoff" after a designated period of user inactivity.
 - 1. A graphic selector list shall allow or limit the graphic displays that a user account has access to.
 - 2. The embedded Web server shall support an unlimited number of user accounts. A minimum of five concurrent user sessions shall be available for simultaneous operator access to the Web server's pages.
 - 3. The embedded Web server shall be compatible with and allow coexistence within standard IT security policies and tools (e.g., Firewall protection).
 - F. The embedded Web server shall provide the following functionality to users via Web browser, Based on their access and privilege rights:
 - 1. Point Navigation – Provide a screen that allows users to see all of the points that are active in the system. The points shall include hardwired, software, schedules, trends, alarms and network setup.
 - a. The point navigation shall display the point name, descriptor, command priority, alarm status, and current value.
 - b. The user shall be able to run and print a pre-configured point log report through a web interface client that shows the point name, descriptor, command priority, alarm status, and current value.
 - c. The interface and report shall allow selection filter such that the operator can select or deselect the types of point that are visible.
 - 2. Alarm Display –displays current BMS alarms to which the user has access will be displayed. Users will be able to acknowledge active alarms, erase resolved alarms, and directly link to the Point Commanding feature.
 - a. The alarm display must provide a filter that displays all alarms whether acknowledged or not.

- b. The alarm display must provide a filter that displays only alarms that have not yet been acknowledged.
 - c. The alarm display must provide a persistent indication whenever there is one or more unacknowledged alarm in any connected field panel.
- 3. Point details – users will have access to point detail information including operational status, operational priority, physical address, and alarm limits, for point objects to which they have access rights.
- 4. Point Commanding – users will be able to override and command points they have access to via the Web browser interface.
- 5. Scheduling – allows operators, depending on their current user privileges, to override schedules selected by date, and to modify the properties of a selected schedule.
 - a. The scheduler display must be able to represent facility mode schedules in a graphical format.
- 6. Trend Data Report – allows users to run and print a pre-configured trend data report for historical data reporting, including a representation of the alarm status of each point for each Trend sample. The report shall allow selection of individual points or wildcard selection of points.
 - a. Trend data shall be exportable to a data file, such as .csv or other comparable.
- 7. Network navigation - Provide a screen that allows users to navigate to the panels and terminal units via the network architecture.
- G. The web server shall be able to send SMTP text messages to notify users of alarm status. The owners shall provide a mail server and a connection port. SSL shall not be required.
- H. The operator shall be able to add modify and delete controller database program, including points, schedules, alarms, and trends.
 - 1. The operator shall be able to edit the custom program in the field panel that executes the sequences of operations, control loops and logic for the systems controlled.
 - 2. The operator shall be able to add terminal unit controllers that reside on field panel subnetworks.
- I. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the Web access feature. Coordinate networking, security, and user access to the Web Server interface with the Owner's IT representative.

2.11 REMOTE MAINTENANCE SERVICES

A. General

- 1. The remote maintenance services program shall be a cloud-based platform which includes monitoring, analysis and reporting deliverables as outlined below. The program shall include a customer portal to document service activity and history including work performed remotely; and allow customers to initiate service requests and view reports

through the portal.

2. The digital services program shall incorporate the software platform, local and remote support, and processes that pro-actively provide system optimization, system diagnostics and workflow.
3. This scope shall include a unified portal and workflow process to concurrently monitoring the health and performance of the building automation system, the automation data network, and the mechanical equipment to provide root cause analysis and identify preventative measures to insure uptime.
4. Service provider must have a dedicated Digital Service Center to manage remote connectivity, ensure data integrity, provide customer support and deliver on centralized service processes.
5. Integrator responsible for the installation, commissioning and delivery of digital services must have a minimum 5 years of experience in providing remote services and analytics.
6. Integrator responsible for weekly data quality analysis to determine values out of range, non-modulating values and values not reporting.

B. Building Automation Services

1. The remote services software shall pro-actively monitor the BAS to prioritize alarms, determine root causes, and identify issues related to connected devices, applications, processes, and server performance. Whenever possible, the service provider shall remotely resolve any issues identified on behalf of the owner or notify them of the need for on-site resolution.
2. Reports – Provide a quarterly preventative maintenance and diagnostics report on system performance KPIs, unique events, event trends and recommended actions.

C. Network Services

1. The digital services shall include data traffic capture and network analysis using diagnostic tools equivalent to Wireshark and Visual BACnet to identify communication failures, network speed deficiencies, and recommended actions to optimize network performance. Whenever possible, the service provider shall remotely resolve any issues identified on behalf of the owner or notify them of the need for on-site resolution.
2. Reports - Provide a quarterly BAS network health report on issues related to excessive BACnet network broadcasting, low hop count, unresponsive network devices and overall network health.

D. Mechanical Services

1. The digital services shall utilize fault detection and diagnostics (FDD) to identify operational inefficiencies, equipment degradation variables, and monitor equipment performance to pro-active identify issues that could impact equipment reliability and optimal energy efficiency. The system shall provide financial savings projections on the impact of implementing related facility improvement measures (FIMs) and have the ability to measure and verify results of corrective measures.
2. Reports – Provide a quarterly report with analytics results, which faults have been resolved remotely, any open faults to address, and recommended actions. Analytics tool shall include estimated savings related to operational optimization and suggested FIMs.

E. Workflow Services

1. The digital services shall include a customer portal to provide - visibility to issues which need to be addressed sooner than the reporting schedule; oversight on service activities being performed remotely or onsite; and provide an interface to request service or order materials.
2. Reports – Performance Report

F. Installation

1. Install equipment in accordance with manufacturer's installation instructions, including all remote connectivity requirements.
2. Set-up and Commissioning of remote maintenance services shall utilize a combination of remote and on-site services to establish data acquisition and analytics for reporting per the defined schedule.
3. Startup and Programming
 - a. Provide certified factory field technician to program systems and ensure proper system installation and operation to achieve the specified digital services.

G. Service and Support

1. Provide factory direct technical support hotline 24 hours per day, 7 days per week.

2.12 GRAPHICS GENERATION AND DISPLAY REQUIREMENTS

A. Graphics Display Requirements

1. Display graphically in up to 256 different colors, the following system information:
 - a. General area maps showing locations of controlled buildings in relation to local landmarks.
 - b. Floor plan maps showing heating and cooling zones throughout the buildings in a range of colors which provide a visual display of temperature relative to their respective set points.
 - c. The colors must be updated dynamically as zone comfort conditions change. Locations of space sensors shall also be shown for each zone.
 - d. Provide set point adjustment and color band displays.
 - e. Mechanical system graphics shall show the type of mechanical system components serving a zone through the use of a pictorial representation of components.
2. Graphics shall provide current values and status of all I/O points being controlled and applicable to each piece of equipment including analog readouts in appropriate engineering units at appropriate locations on the graphic representation.
3. The engineering workstation shall allow receipt of alarms and messages while in a functional mode other than energy management, i.e., incoming alarms shall be displayed while the operator is in a word processing, spreadsheet, or other operating mode.
4. The system must automatically display alarms on a second screen, provide operator ability to respond to an alarm, and return to the exact position left in the previous functional mode.

5. The building operator shall be able to communicate and direct control functions through the use of a "mouse" operator interface to monitor and control functions and sequences within the system.
6. Blocks: Programming, scheduling and set point changes shall be accessible for modification on each menu for the associated equipment. Operator shall be able to automatically download changes from the central site to the appropriate program for the equipment being controlled. Operator shall be able to upload parameters set point information and schedules from the field modules to the central station.
7. Input Format: Operators shall be able to control system functions Based on their password level. The primary operator interface shall be via a mouse type cursor controller.
8. Operator Commands shall be menu driven in the graphics database to include:
 - a. After the operator selects the desired object item or menu, the system shall display either the status of selected object item or the allowable options available.
 - b. Upon entry of a command to the point or points desired as described above, the system shall, before performing a command, respond with an echo of the request.
 - c. This echo feedback shall include the command requested and any entered data.
 - d. System shall include error monitoring software for user's input error.
 - e. A "system" shall consist of a logical grouping of data points, related to a piece of mechanical equipment, an energy distribution system, or an architectural service area.
 - f. For example, in some cases, it may be desired to display, as a single system, a space temperature with its associated air handling unit, and in other cases to display all space temperatures on a floor or in a building.
 - g. The system shall allow such determinations to be made without regard to the physical hardware locations of a point or group of points.
 - h. Likewise, the system shall accommodate future changes of system grouping and operations without field hardware changes.
9. Displays and logs shall contain a header line indicating date, day-of-week, and time. Output displays or logs of a point or group of points shall contain, as a minimum, the following information:
 - a. Graphic presentation of the System
 - b. User name of point
 - c. Point descriptor (Haystack convention)
 - d. Current value/status
 - e. Associated engineering units
 - f. Alarm description
 - g. Trend description
10. User names, point descriptors, and engineering units shall be operator definable on a per point basis.
11. Space Temperature Representation: Utilize a contiguous band of colors each

corresponding to actual zone temperatures relative to the desired heating and cooling set points.

- a. The ideal temperature shall be shown as a green color band. This color band corresponds to the dead-band between the onset of mechanical heating or cooling.
- b. Show temperatures slightly warmer than ideal in yellow and even warmer temperature in orange.
- c. Temperatures slightly cooler than ideal shall be light blue
- d. Even cooler temperatures shall be dark blue.
- e. Alarm colors shall be in red.

12. Passwords: User Access Restriction.

- a. Operator sign-on shall require an assignable password.
- b. Each operator can be assigned to one of ten levels of system access.

B. Graphics Generation Requirements

1. Construction: Permit the easy construction of infinitely variable shapes and sizes through the use of the mouse pointing device. A selection of 256 colors and various fill textures, line types and text styles shall all be accessible through the use of the mouse interface. The software shall resemble many of the computer aided design programs currently available and allow graphics to be easily moved, edited, added or deleted. Graphics software shall be fully implemented and operational to accomplish the following:
 - a. Create a new graphic picture
 - b. Modify a portion of a graphic picture
 - c. Delete a graphic picture, or any portion thereof
 - d. Call up a graphic picture
 - e. Cancel the display of a graphic picture
 - f. Assign conditions which automatically initiate the display
 - g. Overlay alphanumeric and graphics
 - h. Save the graphic picture
 - i. Display latest process data fully integrated with the graphic display
 - j. Display Live Graphical Software Programs
 - k. The central station must be able to generate standard ASCII file formats to allow use with third-party software to generate and store owner-designed reports.

C. Graphics Application Requirements

1. All graphics shall be available with the same look and functionality whether they are displayed at an installed client console or in a browser.
2. User shall be able to add/delete/modify system graphics for floor plan displays and system schematics for each piece of mechanical equipment (including, air handling units,

- chilled water systems, hot water boiler systems, and room level terminal units) from standard user interface without the need of any external or specialized tools.
3. The software shall include all necessary tools and procedures for the user to create their own graphics.
 4. The software shall provide the user the ability to display real-time point values by animated motion or custom picture control visual representation.
 5. The software shall provide animation that depicts movement of mechanical equipment, or air or fluid flow.
 6. The software shall provide users the ability to depict various positions in relation to assigned point values or ranges.
 7. The software shall provide the ability to add custom gauges and charts to graphic pages.
 8. The software must include a library of at least 400 standard control application graphics and symbols for visualizing common mechanical systems, including fans, valves, motors, chillers, AHU air handling systems, standard ductwork diagrams, piping, and laboratory symbols.
 9. The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.
 10. The Graphics application shall be capable of automatically assigning the appropriate symbol for an object (point) selected to be displayed on the graphic Based on what the object represents (fan, duct sensor, damper, etc.) when the object is placed on a graphic.
 11. The Graphics application shall allow a user to manually override the automatically assigned symbol for an object when a different symbol is desired.
 12. The user shall have the ability to add custom symbols to the symbol library.
 13. The software shall permit the importing of scanned pictures and images for use in graphics with support of JPG, PNG, and SVG files.
 14. Graphics must be automatically associated to any points or system objects that are rendered on the graphic, so that selection of a system object will allow a user to simply navigate to any associated graphic, without the need for manual association.
 15. The software must allow users to command points directly off graphics application.
 16. Graphic display shall include the ability to depict real-time point values dynamically with text or animation.
 17. Graphics viewing shall include the ability to switch between multiple layers with different information on each layer.
 18. Graphics shall include a decluttering capability that allows layers to be programmatically hidden and displayed Based on zoom level.
 19. Graphics shall be capable of displaying the status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.
 20. The software must provide the ability to create dashboard views consisting of gauges and charts that graphically display system and/ or energy performance.

2.13 BACNET BUILDING CONTROLLER HARDWARE (B-BC)

- A. Provide all necessary hardware for a complete operating system as required. The Building Controller shall be able to operate as a standalone panel and shall not be dependent upon any higher-level computer or another controller for operation.
- B. Basis of Design: Siemens PXC Series.

- C. This controller shall have the BTL listing and meet the BACnet device profile of a Building Controller (B-BC).
 - 1. Controller shall support BACnet/SC and BACnet/IP.
- D. This level of controller shall be used for the following types of systems:
 - 1. Air handling units.
- E. Computing power and memory minimum:
 - 1. A stand-alone, multi-tasking, multi-user, real-time 1.2GHz digital control microprocessor module.
 - 2. Inputs shall be 16-bit minimum analog-to-digital resolution
 - 3. Outputs shall be 10-bit minimum digital-to-analog resolution
 - 4. Memory module (2GB, minimum) to accommodate all Primary Control Panel software requirements, including but not limited to, its own operating system and databases (see Controllers Software section), including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, dial-up communications.
 - 5. Real time clock and battery
 - 6. Data collection/ Data Trend module sized for 10,000 data samples.
 - 7. Flash Memory Firmware: Each Building Level Control Panel shall support firmware upgrades without the need to replace hardware.
- F. Communication
 - 1. 2-Port Ethernet switch cabling compatible with star, bus or daisy chain topology.
 - 2. WLAN connection for service, commissioning and firmware upgrade.
 - 3. Web user interface is accessible over HTTP or securely over HTTPS.
 - 4. Individual 3rd Ethernet port for local service/tools connection.
- G. Input and Output Points Hardware
 - 1. Input/output point expansion modules shall be installed as required to include 20% spare capacity of points.
 - 2. Input/output point modules shall have removable terminal blocks.
 - 3. Monitoring of the status of all hand-off-auto switches.
 - 4. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
 - 5. Local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.
 - 6. Graduated intensity LEDs or analog indication of value for each analog output.
 - 7. Optional HOA (hand-off-auto module) with software configurability and LED status indicators.
- H. Code compliance

1. Approvals and standards: UL916; CE; FCC
 2. Provide UL864-UUKL where called for in the sequences of operations.
- I. Accessories:
1. Appropriate NEMA rated metal enclosure.
 2. Power supplies as required for all associated modules, sensors, actuators, etc.
- J. The operator shall have the ability to manually override automatic or centrally executed commands at the primary control panels via local, point discrete, on-board hand/off/auto operator override switches. If on board switches are not available, provide separate control panels with HOA switches. Mount panel adjacent to primary control panel. Provide hand/off/auto switch for each digital output, including spares.
- K. Panel setup, point definitions and sequencing diagrams shall be backed up on EEPROM memory.
- L. Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.
- M. Building Level Controllers shall have the capability to serve as a gateway between Modbus subnetworks and BACnet objects. Provide software, drives and programming.
- N. Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be “future” on drawings and 20% more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.
- O. Environment.
1. Controller hardware shall be suitable for the anticipated ambient conditions.
 2. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
 3. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
 4. Controller hardware shall be optionally suitable for rooftop environments.
- 2.14 BACNET ADVANCED APPLICATION CONTROLLERS (B-AAC) As Applicable
- A. Provide all necessary hardware for a complete operating system as required. The Advanced Application control panel shall be able to operate as a standalone panel and shall not be dependent upon any higher-level computer or another controller for operation.
- B. Basis of Design: Siemens DXR.
- C. Controller software shall be capable of BACnet communications. The controller shall have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet device profile as specified in ANSI/ASHRAE 135.
1. Controller shall support BACnet/SC and BACnet/IP.
- D. Communication: Controller shall support the BACnet IP Data Link Layers.
- E. The software programs specified in this section shall be provided as an integral part of

- controllers and shall not be dependent upon any higher-level computer or another controller for execution.
- F. Controllers shall have the ability to perform energy management routines including but not limited to
1. Scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides
 2. Automatic daylight savings time switch over
 3. Night setback control
 4. Economizer switch over using enthalpy, dry bulb or a combination
 5. Peak demand limiting,
 6. Temperature-compensated duty cycling
 7. Heating/cooling interlock
 8. Supply temperature reset
 9. Priority load shedding
 10. Power failure restart
- G. The software shall have a routine for automatic tuning of control loops
- H. System Security in the Field Panel
1. User access shall be secured using individual security passwords and user names.
 2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
 3. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
 4. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the field panel.
- I. User Defined Control Applications:
1. Controllers shall be fully-programmable. Controllers shall execute custom, job-specific sequences to automatically perform calculations and special control routines. Factory installed or pre-configured sequences shall only be allowed if they exactly match the sequence specified herein.
 2. Programs shall combine control logic, control loop algorithms, and energy management routines
 3. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.
 4. Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task oriented information from the user manual.
- J. Input/Outputs
1. Inputs shall be 16-bit minimum digital resolution
 2. Outputs shall be 10-bit minimum digital resolution
 3. The following I/O port types shall be available on the controller
 - a. Universal Input (software configurable):
 - i. Digital Input choices:

1. Pulse Accumulator
2. Contact Closure Sensing
3. Dry Contact/Potential Free inputs only
4. Digital Input (10 ms settling time)
5. Counter inputs up to 20 Hz, minimum pulse duration 20 ms (open or closed)

ii. Analog Input Choices:

1. 0-10 Vdc
2. 4-20 mA
3. 1K Ni RTD @ 32°F (Siemens, DIN Ni 1K)
4. 1K Pt RTD (375 or 385 alpha) @ 32°F
5. 10K NTC Type 2 or Type 3 Thermistor
6. 100K NTC Type 2 Thermistor

b. Universal Input or Output (software configurable):

- i. All of the above input types
- ii. Analog Output Types:

- a. 0 to 10 Vdc @ 1 mA max

c. Super Universal Input or Output (software configurable):

- i. All of the above input types
- ii. All of the above output types
- iii. Super digital output type:

1. 0 to 24 Vdc, 22 mA max. (for controlling pilot relay)

iv. Super Analog Output Choices:

1. 0 to 20 mA @ 650 Ω max.

4. Provide software configurable I/O ports such that a programmer make a port either an input or an output
- K. Power loss. In the event of the loss of power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for the operating system software and firmware.
- L. Database Restore: Each controller shall automatically save the latest programmed database. The controller shall be able to automatically restore a lost or corrupt database without involvement from the operator.
- M. Each Control Panel shall support firmware upgrades without the need to replace hardware.

2.15 BACNET APPLICATION SPECIFIC CONTROLLERS (B-ASC) N/A

- A. Each Application Specific Controller shall operate as a stand alone controller capable of performing its user selectable control routines independently of any other controller in the system. Each Application Specific Controller shall provide standard applications and

- programmability to provide both reliability and flexibility. Each application specific controller shall be a microprocessor based, multi tasking, digital control processor.
- B. Basis of Design: Siemens DXR.
 - C. Configurable control applications. Each Application Specific Controller model must have a set of pre-loaded, selectable and field-adjustable control applications appropriate for the secondary HVAC equipment that the controller model is intended to control. Specific applications must be configurable to meet the user's control strategy requirements, allowing for additional system flexibility.
 - D. Programmability: Application Specific Controllers shall be programmable. Program language shall be graphical.
 - E. Each Application Specific Controller model must have a set of pre-loaded, selectable and field-adjustable control applications for lighting equipment control, independent from or in conjunction with the HVAC control applications, which can be enabled if the appropriate lighting control devices are connected.
 - F. Each Application Specific Controller model must have a set of pre-loaded, selectable and field-adjustable control applications for shading equipment control, independent from or in conjunction with the HVAC control applications, which can be enabled if the appropriate shading control devices are connected.
 - G. The Application Specific Controller shall include all point inputs and outputs necessary to perform the specified HVAC control sequences. The controller shall accept input and provide output signals that comply with industry standards. Controllers utilizing proprietary control output signals shall not be acceptable. Controllers shall provide outputs utilized either for two-state, modulating floating, or proportional control, allowing for additional system flexibility.
 - 1. Analog inputs shall be software configurable to accept sensors using 0-10v (such as RH or CO2 sensors), NTC3k, NTC10k, NTC100k, Ni1000, PT1K 385, and resistance sensors of 1000 Ω , 2500 Ω , 10K Ω , and 100k Ω . 24vDC power to drive active sensors shall be an option available from the controller.
 - 2. Digital input
 - 3. Analog Outputs shall support 0-10v HVAC control signals.
 - 4. Digital outputs shall be AC 24V high-side switching triacs, able to switch loads of 250 mA / 6 VA per output.
 - 5. Every installed Application Specific Controller shall be prepared for the addition of occupancy, CO2 and humidity sensors
 - 6. Additional sensors and output modules for occupancy, lighting and shade control within the same space as the HVAC control shall be connected as needed via a sub-network connection on each Application Specific Controller
 - 7. The Application Specific Controller shall be compatible with a Siemens Room Unit which combines a display with CO2, temperature and humidity sensing in 1 wall device.
 - 8. The Application Specific Controller shall be compatible with a Siemens Room Unit which combines a display with temperature sensing and configurable switches for lighting, shade and scene control in 1 wall device.
 - H. Application Specific Controller communication
 - 1. Communication over floor level network shall be BACnet IP over Ethernet unless otherwise required by the application.
 - 2. Each controller that uses BACnet IP shall provide at least two Ethernet ports allowing the

controllers to be wired in a daisy-chain configuration of up to at least 20 controllers per chain, utilizing standard Ethernet cables of up to 300ft in length between each controller.

- I. The Application Specific Controller shall have the BTL listing and meet the BACnet device profile of an Application Specific Controller (B-ASC) as specified in ANSI/ASHRAE 135.
 - 1. Controller shall support BACnet/SC and BACnet/IP.
- J. The Application Specific Controller shall provide for control of each piece of equipment, including, but not limited to the following:
 - 1. Variable Air volume (VAV)
 - 2. Constant Air volume (CAV)
 - 3. Hot water and electric reheat Coils (RH)
 - 4. Fan Coil Units (FCU)
 - 5. Fan Powered Boxes (FPB)
 - 6. Unit Conditioners
 - 7. Unit Ventilators
 - 8. Baseboard radiator
 - 9. Chilled/heated ceiling panels
 - 10. DX cooling and chilled water coils
 - 11. Unitary units.
 - 12. Split systems.
- K. Coordination between Application Specific Controllers. In situations where more than one controller is serving a common space, it must be possible through configuration only (not reprogramming) to subordinate one or more Application Specific Controllers to another Application Specific Controller allowing multiple controllers to coordinate HVAC control in a large space.
- L. Application Operating Modes - All of the following operating modes shall be supported, with configurable operation of each controlled device during each mode.
 - 1. Comfort, Standby (Pre-comfort), Economy, and Building Protection modes
 - a. Comfort: Space is occupied
 - b. Standby (Pre-comfort): Space has been or will be unoccupied for a short time
 - c. Economy: Space has been or will be unoccupied for a longer time
 - d. Building Protection: Space has been or will be unoccupied for a more than a day
 - 2. Configurable set points and limits for each mode.
 - a. The operating mode can be changed by system schedule or command or by conditions in the space such as by presence detection.
 - b. All controlled devices shall respond to changes in operating mode in a configurable way such as set point resets after a configurable time to optimize energy consumption.

- M. Room Units / HMIs shall provide an intuitive user alert to indicate energy-efficient operation or when there is unnecessary energy consumption, and provide occupants with a one-touch

release to return to efficient, comfortable control. Energy efficient operation shall be determined by configurable and programmable algorithms provided by the Application Specific Controller and shall include (but not be limited to) the following conditions:

1. Temperature set point is set outside customer-specified limits.
 2. Fan Speed is overridden to a higher speed than is required for automated temperature control.
- N. The energy efficiency status for each Application Specific Controller and space shall also be available as BACnet object at the BMS for operating and monitoring.
- O. Scene control. The Application Specific Controller shall provide a set of configurable and field-adjustable presets of HVAC modes that can be activated by pressing assigned buttons on the Room Unit / HMI.
- P. Application Specific Controller Configuration and Commissioning Tool
1. Provide industry standard, commercially available laptop to host the Application Specific Controller Configuration and Commissioning Tool. The tool shall plug directly into all controllers as described below:
 2. Functionality of the Configuration and Commissioning Tool connected to any Application Specific Controller shall include:
 - a. Provide connection capability at either the controller, a related room unit, through a BACnet router or through a Siemens Apogee Field Panel controller to access controller information.
 - i. When connected via a related room unit to a controller, the tool shall be able to access information of the controller the room unit is connected to and all controllers connected to the same MS/TP or IP network.
 - ii. Connection of the Tool to a controller shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted or preclude centrally-initiated commands and system modification.
 - iii. Tool access to controller shall be password-controlled. Password protection shall be configurable for each operator based on function, points (designating areas of the facility), and edit/view capability.
 - b. Provide device discovery, configuration and setup for addressing and network management of multiple devices from one connection point (location) in parallel.
 - c. Select, view, command, change, and enable/disable features and functionality of the control application.
 - d. Load pre-designed templates of configuration settings and allow copying of templates to other controllers in order to speed the commissioning process.
 - e. Provide status, setup, balancing and control reports to

support commissioning and troubleshooting activities.

- f. Backup and restore of application configurations
- g. Air flow balancing.

i. For every air flow sensing channel in the Application Specific Controller control application, the Tool shall offer an interface and menu specifically designed to support the Test, Adjust, and Balance functions. Through the balancing menu, the controller enables the following operations:

- a. Select the operating point for the test from a list of named operating points, including maximum and minimum cooling, maximum and minimum ventilation and maximum and minimum heating.
- b. Accept the balancer's flow measurement as a manually entered value.
- c. Automatically calculate and display the revised flow calibration factor.
- d. Apply the new calibration factor on command.

ii. The Application Specific Controller shall maintain a BACnet object reflecting the TAB state of the controller as: Initial, Balancing, Balanced. The Application Specific Controller records data representing the TAB process, and stores for later retrieval. The controller delivers the data when called for producing reports. Stored data includes:

- 1. Air balancer's air flow measurement.
- 2. Controller's air flow measurement after correction.
- 3. Named test point (max cooling, etc.).
- 4. Initial calibration factor.
- 5. Applied selected calibration factor

iii. The tool should allow configuring, loading and balancing multiple controllers from one connection point (location) in parallel

iv. The Ethernet / IP Application Specific Controller models shall provide web pages for troubleshooting and operation and monitoring which can be accessed via a standard web browser

Q. Each Application Specific Controller shall, at a minimum, be provided with:

- 1. Appropriate NEMA rated enclosure
- 2. Power supplies as required for all associated modules, sensors, actuators, etc.
- 3. Each controller measuring air volume shall include a differential pressure transducer
- 4. Approvals and standards: UL916 PAZX; CUL; FCC

R. Each Application Specific Controller shall continuously perform self-diagnostics on all hardware and secondary network communications. The Application Specific Controller shall

provide both local and remote annunciation of any detected component failures or repeated failure to establish communication to the system.

- S. Power Supply. The Application Specific controller shall be powered from a 24 VAC source and shall function normally under an operating range of -15% / +20%.
- T. All controller configuration settings and programs shall be stored in non volatile memory. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.
- U. Environment. The controllers shall function normally under ambient conditions of 23 to 122°F (-5 to 50°C) and 5% to 95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the circuit board assembly.

2.16 ALARM PROCESSING

- A. Alarms shall be classified by their alarm type. The facility shall be provided for enabling and disabling each individual alarm on the system.
- B. Once generated, the alarm shall be processed by its associated alarm type as defined in the I/O Point Schedules. The alarm types shall be as follows:
 - 1. General Mismatch
 - 2. Critical Mismatch
 - 3. General Binary
 - 4. Critical Binary
 - 5. General Analog
 - 6. Critical Analog
 - 7. Alarm Inhibition
- C. Consequential alarm suppression algorithms shall be provided to limit the alarms annunciated on the DDC System to those associated with the source of the initial alarm condition e.g. fire alarms shall not initiate mismatch alarms, restoration of power following a power failure shall not initiate mismatch alarms etc.

2.17 CONFIGURATION

- A. Configuration data shall be stored in the DDC Controllers or the Terminal Unit Controllers. Configuration data shall include but not be limited to the following:
 - 1. The unit applicable (deg F, GPM's, inches, etc.).
 - 2. The point identifier (minimum of 12 characters).
 - 3. The point alarm message if applicable (minimum of 80 characters).
 - 4. The point descriptor (minimum of 32 characters).

2.18 DDC STANDARD PROGRAMS

- A. The device schedules included in this Specification provide details of inputs monitored and outputs controlled by the DDC System. All point types are described under Controllers elsewhere in this Specification. The DDC System shall allow for the following point functionality and standard programs to be available:
 - 1. Point Override
 - 2. Manual Start/Stop

3. Fixed Time Program
4. Optimum Start/Stop
5. Control Loops
6. Rotational Point
7. Run Time Totalization
8. KWH calculations
9. Anti-Short Cycling
10. Staggered Start
11. User Definable Software
12. General Control Requirements

2.19 INTEGRATIONS

- A. The BMS shall utilize and be compatible with industry-standard integration protocols (BACnet and Modbus) for subsystem integration. Coordinate integration protocols with subsystem manufacturer.
- B. In addition to the above, the BMS shall be integrated with all pump and fan VFDs via BACnet IP. All software points shall be made available at the BMS for monitoring.
- C. N/A - The BMS shall be interfaced to the existing BMS control systems via communication gateways furnished and installed by this Contractor. Communication gateways shall be utilized to discover the existing system software points and translate the information to be integrated to the new BACnet BMS. Provide gateways for integration of the following protocols to BACnet/IP or BACnet MS/TP:
 1. Johnson Metasys N2
 2. Johnson Controls Facility Explorer (FX)

2.20 CONTROL PANELS

- A. Fully enclosed, steel-rack-type cabinet with locking doors or locking removable backs. Match finish of panels and provide laminated as-built wiring diagrams, flow diagrams, etc. related to the system being controlled inside the associated cabinet. Each control panel shall be clearly and permanently labeled with the controller designation and indication of the mechanical equipment served.
- B. Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.
- C. Field equipment panels located indoors shall be NEMA 1. Field equipment panels located outdoors or subject to outdoor air conditions shall be minimum of NEMA 3R, provided with internal electric heater and cooling fan.
- D. Coordinate installation of the control panels with the engineer/architect.
- E. Coordinate power for the panels with the electrical contractor.
- F. All control panels shall be provided with DIN Rail mounted screw terminal blocks. Field wiring shall be connected to the screw terminal blocks. It is not acceptable to terminate any field wiring directly to the DDC controller or any panel devices such as relay and transducers. The screw terminal blocks located/attached to the DDC controller alone does not comply with this requirement.
- G. All control devices such as relays, transformers, transducers, power supplies, associated I/O devices, etc. shall be installed inside the panel, not at the starter or electrical junction box.
- H. All panel wirings shall in be installed in Panduit and wiring duct. This shall include but not

be limited to wiring from the DDC controller to the terminal block, between DDC controller and relay (and other panel mounted control devices), power wiring for the controller, communication, etc.

- I. Primary control panels shall be assembled, wired, pre-commissioned and tested by union-electricians in a controlled factory environment prior to being shipped to the jobsite. Field assembly of primary control panels shall not be acceptable.
- J. Accessories
 - 1. Maintained Panel-Mounted: Relay shall be "ice-cube" style with corresponding DIN rail mountable socket. Outputs shall be SPDT, DPDT, 3PDT, or 4PDT type rated for 10A switching capacity. Each shall be provided with manual check buttons and LED indicators. Relay shall be RH Series as manufactured by IDEC, or as approved by Engineer.
 - 2. Maintained Field-Mounted: Relay shall be enclosed with LED indicator. Output shall be SPDT type rated for 10A switching capacity. Relay shall be RIBU1C as manufactured by Functional Devices, or as approved by Engineer.
 - 3. Time Delay Relay
 - a. Time delay relays shall be of the on-delay (delay-on-make) or off-delay (delay-on-break) type, based on the application. The timer shall have a single adjustable time range and contain an analog user input (potentiometer, dial, switch, etc.). The timer shall have an electromechanical relay output (DPDT type), rated for a minimum of 5 amps, and shall be powered by an external AC or DC power supply. The timer shall be capable of operating at an ambient temperature range of 13°F to 140°F.
 - b. The time delay relay repeatability accuracy shall be $\pm 0.5\%$ with an overall accuracy of $\pm 1.0\%$ and shall have an electrical life of 100,000 operations at rated load. Timing adjustment shall be capable of user adjustment, specific to the application at use. Time delay relays shall be as manufactured by Square D, ASCO, Agastat or as approved by the Engineer.

2.21 SENSORS

- A. All control signals shall be via 4-20 mA or 0-10 VDC loops.
- B. Input/output sensors and devices shall be closely matched to the requirements of the DDC for accurate, responsive, noise-free signal input/output. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control. Thermistors are acceptable for VAV terminal applications.
- C. Temperature Sensors
 - 1. Provide the following instrumentation as required by the monitoring, control, and optimization functions. All temperature sensors shall use platinum RTD elements only, nickel or silicon RTD's and thermistors are not acceptable.
 - 2. Temperature Transmitter Assembly – Airstream averaging type
 - a. The assembly shall consist of a capillary type 1000-ohm platinum RTD housed in a flexible sheath contained in housing suitable for duct mounting.
 - b. Accuracy: $\pm 0.25^\circ\text{F}$

3. Temperature Transmitter Assembly – Airstream non-averaging type

- a. The assembly shall consist of an insertion type 1000-ohm platinum RTD mounted on a 12-inch probe (or duct diameter) contained in a housing suitable for duct mounting.
- b. Accuracy: $\pm 0.25^{\circ}\text{F}$
- c. For outside air application mount with weather protection and sun shield.

4. Low Temperature Limit Switch (Freezestat) – Airstream

- a. The low temperature limit switch shall be of the automatic reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
- b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
- c. Provide one freezestat per coil section or a maximum of 18 square feet whichever is more provides more coverage.

5. Temperature Transmitter – Space

- a. The assembly shall consist of a 1000-ohm platinum RTD contained in a decorative ventilated enclosure similar in appearance to room thermostats.
- b. Accuracy: $\pm 0.25^{\circ}\text{F}$
- c. Temperature transmitters for terminal unit applications (such as VAVs, FPBs, FCUs, etc.) shall utilize industry-standard KNX protocol.
- d. Cover type (i.e. indicating, adjustable, blank), colors, and final installation locations shall be as reviewed approved by the architect, owner, and engineer. In general, occupied spaces (i.e. offices, conference rooms, etc.) shall be provided with indicating temperature display (LCD) and setpoint adjustment ($\pm 3^{\circ}\text{F}$); transient spaces (i.e. open office area, hallways, etc.) shall be provided with blank non-indicating and non-adjustable sensors. Note: All adjustable sensors are subject to ADA requirements.

6. High Temperature Thermostat – Space

- a. High temperature room thermostat shall contain bi-metallic switches, SPDT rated for 5 amps at 120 VAC

7. Temperature Transmitter – Liquid Immersion

- a. Sensing element RTD
- b. Temperature range Suitable for application
- c. Output signal 4-20 mA
- d. Accuracy $\pm 0.15^{\circ}\text{F}$
- e. Provide Type 304 stainless steel thermowell for each liquid immersion temperature sensing element.

D. Humidity Sensors

1. Relative Humidity – Space

- a. Sensor Humidity range 0 to 100%
- b. Accuracy $\pm 4\%$ RH (20-80% RH).
- c. Sensing element Digital Sensor IC (capacitive)
- d. Provide with readable LCD display where indicated in the sequences or drawings
- e. For rooms with temperature sensing as well, provide a combined temperature/humidity sensor or provide units with matching cover.

2. Relative Humidity – Duct

- a. Sensor humidity range 0 to 100%
- b. Accuracy $\pm 2\%$
- c. Sensing element Digital Sensor IC (capacitive)
- d. Output signal 4-20 mA/0-5V/0-10V selectable
- e. Calibration adjustment adjustable to $\pm 5\%$ RH

3. Outside-Air Sensors: Provide duct-mounted sensor with element guard and mounting plate.

E. Pressure Sensors/Switches

1. Airside Differential Pressure Transmitter

- a. Non-directional sensor with suitable range for expected input, and temperature compensated.
- b. Assembly to include integral mounting bracket
- c. Accuracy $\pm 1\%$ of Full Scale
- d. Output 4 to 20 mA or 0-10 VDC (selectable)
- e. Static Pressure Ranges
 - i. Building 0 to 0.25 inches wg.
 - ii. Duct 0 to 5 inches wg.
 - iii. AHU Filter 0 to 1 inch wg. (Coordinate with manufacturer)

2. Airside Static Pressure Switches

- a. Diaphragm type air differential pressure switches with die cast aluminum housing, adjustable setpoint, minimum 5 amp switch rating at 120VAC, SPDT switches. Switch pressure range and set point shall be suitable for the application. High and low ports shall be 1/8 inch NPT connected to angle type tips designed to sense pressure.
- b. Reset-type based on applications:
 - i. Fan status Automatic Reset
 - ii. Hi/Lo Static Safety Manual Reset

- c. Provide AFS Series as manufactured by Cleveland Controls or pre-approved equal.

F. Current-Sensing Relays

1. Relay shall be field-adjustable for detecting AC current levels in equipment served. Relay shall be non-latching and shall have no time delay. Nominal input voltage and current-sensing range shall be selected based on electrical characteristics of equipment served. Relay shall be installed on one (1) lead of the load side of motor feed. Relay contacts shall be Form C-rated for 5A at 120 VAC.

G. Leak Detection

1. Point-Type Leak Detector: Leak detector shall provide single-point detection of leaks. Sensing probe shall be gold-plated to prevent corrosion. Sensor shall be provided with adjustable mounting brackets to allow for height and leveling adjustment. Sensing probes shall be adjusted to 1/8 in. of floor. Power requirements shall be 24 VAC, 100 mA. Enclosure shall be NEMA 1. Output relays shall be 2 Form C, 3A rating at 24 VAC. Detector shall be manufactured by Liebert Model LT-410 or as approved.

H. Airflow Measuring Station

1. Airflow-temperature-measurement station shall be capable of monitoring airflow and temperature rates. Sensors shall use thermal dispersion technology with multiple temperature and velocity point on each measurement point. The system shall be factory-tested prior to shipment and not require calibration or adjustment of the life of the equipment. Each sensor probe shall be provided with a UL plenum-rated connecting cable with circular terminal connectors and gold-plated contacts. Connecting cable shall be a minimum of 10 feet of length (up to 50 feet) for each probe. Sensor probes shall be of plug-and-play design and do not have to be matched to a specific transmitter. All sensor calibration data shall be stored in the sensor probe.
2. Sensors
 - a. Sensors shall be factory-calibrated at a minimum of sixteen (16) airflow rates and three (3) temperatures to NIST-traceable standards for both airflow and temperature. Each sensing point shall independently measure airflow and temperature prior to averaging. Installed accuracy shall be percent of reading and demonstrated at both maximum and minimum airflow rates for each measurement location. Airflow sensor accuracy shall be $\pm 2\%$.
 - b. Provide a minimum of 4 sensors for every 2 sq. ft. of AHU or duct cross-section or as per manufacturer's requirements to meet specified accuracy and performance.
3. Transmitter
 - a. Transmitter shall be microprocessor-based and capable of processing up at least to sixteen (16) independent sensing points per location. All connectors and interconnects shall have gold-plated contacts. The transmitter shall operate on 24 VAC and be internally fused and protected. The transmitter shall have a 16-character alphanumeric LCD display for airflow, temperature and system

diagnostics. Analog output signals shall be field-selectable (0 - 10 VDC or 4 - 20 mA). All inputs and outputs shall be fused, protected and internally insulated from the 24 VAC power supply. The sensor shall be capable of continuously performing sensor and transmitter diagnostics and perform a full-system check on power-up. The transmitter shall be capable of indicating individual sensor airflow and temperature readings on the LCD display. The enclosure shall be aluminum alloy for indoor use and shall be capable of operating over a temperature range of 30°F to 120°F. Transmitter accuracy shall be 3% to 10% of reading. Repeatability shall be 0.25%. Probe construction shall be 304 stainless steel, including housing and mounting feet. Temperature sensor accuracy $\pm 0.15^\circ\text{F}$. Temperature range shall be -20°F to 160°F .

4. Basis of Design: Ebtron Gold Series.

I. BTU Meter – 3” and larger

1. BTU meters shall be used to meter chilled and hot water energy usage. Refer to drawings for quantity and locations of meters.
2. BTU meter shall be single-channel type comprised of a BTU computer, flow sensors and temperature sensors. BTU meter shall be capable of providing the following values to the BMS: Energy Total, Energy Rate, Flow Rate, Supply Temperature.
3. BTU Computer
 - a. Power Supply 108-132 VAC @ 50/60 Hz
 - b. Display White, backlit, 16-character, 8-line numeric LCD
 - c. Outputs
 - i. Three (3) pulse outputs for energy total or mode operation.
 - ii. One (1) analog output, field selectable 4-20 mA or 0-10 V.
 - d. Digital Communication BACnet MS/TP or BACnet IP
4. Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched (NIST* traceable) for the specific temperature range for each application. The calculated differential temperature used in the energy calculation shall be accurate to within $+0.15^\circ\text{F}$ (including the error from individual temperature sensors, sensor matching, input offsets, and calculations).
5. Flow sensor shall be in accordance with “Flow Meter” as specified below.
6. BTU meter shall be Onicon System 10, or approved equal.

J. BTU Meter – Up to 2-1/2”

1. BTU meters shall be used to meter chilled and hot water energy usage. Refer to drawings for quantity and locations of meters.
2. BTU meter shall be single-channel type comprised of a BTU computer, flow sensor and temperature sensors. BTU meter shall be capable of providing the following values to the BMS: Energy Total, Energy Rate, Flow Rate, Supply Temperature.
3. BTU Computer

- a. Power Supply 20-28 VAC @ 50/60 Hz
 - b. Enclosure Rating IP65 with display
 - c. Outputs
 - i. One (1) auxiliary pulsed output.
 - ii. One (1) analog output, field selectable 4-20 mA or 0-10 V.
 - d. Digital Communication BACnet MS/TP
4. Temperature sensors shall be insertion-type matched pair of 1000 OHM RTD sensors. Temperature sensors shall be certified and matched to an uncertainty of less than 0.18 deg. F. over the operating range.
 5. Flow sensor shall be integral with BTU computer/display and shall meet the following criteria:
 - a. Technology Inline wetted ultrasonic
 - b. Accuracy $\pm 1\%$ over 25:1 turndown, $\pm 2\%$ over 100:1 turndown
 - c. Overall Turndown 500:1
 6. BTU meter shall be Onicon System 40, or approved equal.

K. Ultrasonic Flow Meter – 3” and larger

1. Flow meter shall be clamp-on transit time ultrasonic flow meter complete with matched transducers, self-aligning installation hardware and coaxial transducer cables.
2. Flow meter shall be installed without making any openings in the pipe wall and shall utilize non-wetted ultrasonic transducers that may be located up to 300 ft from the meter. Ultrasonic transducers shall be optimized for the specific pipe & process conditions for each application and the transducer frequency shall be automatically matched to the resonant frequency of the pipe at start-up. An integral auto-zero function shall be provided for zero precision and high accuracy.
3. Flow meter shall meet the following criteria:
 - a. Technology Ultrasonic
 - b. Measurement Principle Transit-time difference
 - c. correlation principle Accuracy $\pm 1\%$ from 1 to 40 ft/s, ± 0.01 ft/s below 1 ft/s
 - d. Turndown 400:1
 - e. Outputs
 - i. One (1) auxiliary pulsed output.
 - ii. One (1) analog output, field selectable 4-20 mA or 0-10 V.
 - f. Digital Communication BACnet MS/TP
4. Provide remote mounting of display at eye level for applications where flow sensor is

located above 10 ft. For all other locations, transmitter shall be mounted to flow sensor assembly.

5. Flow meter shall be Onicon Model F-4200, or approved equal.

L. Ultrasonic Flow Meter – Up to 2-1/2”

1. Flow meter shall be inline complete with direct beam wetted ultrasonic transducers, temperature sensor, mounting hardware and calibration certificate
2. Flow meter shall be installed without making any openings in the pipe wall. Ultrasonic transducers shall be optimized for the specific pipe & process conditions for each application and the transducer frequency shall be automatically matched to the resonant frequency of the pipe at start-up.
3. Flow meter shall meet the following criteria:
 - a. Power Supply 20-28 VAC @ 50/60 Hz
 - b. Technology Ultrasonic
 - c. Measurement Principle Transit-time difference
 - d. correlation principle
 - d. Accuracy $\pm 1\%$ over 25:1 turndown, $\pm 2\%$ over 100:1 turndown
 - e. Overall Turndown 500:1
 - f. Outputs
 - i. One (1) auxiliary pulsed output.
 - ii. One (1) analog output, field selectable 4-20 mA or 0-10 V.
 - g. Digital Communication BACnet MS/TP
4. Flow meter shall be Onicon Model F-4600, or approved equal.

2.22 AUTOMATIC CONTROL VALVES

A. General

1. All control valves shall be electrically actuated and shall include a handle or wheel for manual override.
2. Unless otherwise indicated on the control diagrams or in the sequences of operation, valve fail positions shall be:
 - a. AHU Preheat Coil Fail Open
 - b. AHU Cooling Coil Fail Closed
 - c. Isolation Valve Fail Closed
3. Valves shall have sufficient stuffing box protection to ensure against leakage at hydrostatic head involved. Control valve operators shall be sized to close against differential pressure equal to the design pump head plus 10 percent. Valve leakage shall meet or exceed ANSI Class IV leakage (0.01% of rated valve capacity).
4. Valve actuators shall be factory installed on valve bodies. Field installation of actuators is not acceptable.

B. Two-way Modulating Control Valves – Up to 2”

1. Two-way modulating control valves shall be globe-style with equal percentage flow characteristic for water service and linear flow characteristic for steam service.
2. Performance:
 - a. Pressure Rating ANSI 250
 - b. Close-off Pressure Pump head plus 10%
 - c. Leakage ANSI Class IV
 - d. Temperature Range 20 to 250°F
 - e. Rangeability 100:1
3. Material construction:
 - a. Body Bronze
 - b. End Connection NPT Threaded
 - c. Trim Brass
 - d. Stem Stainless Steel
4. Input power voltage shall be 24VAC.
5. Control signal to valves shall be via hardwired analog output (0-10 VDC).
6. Valves shall be Siemens Two-Way Flowrite, or approved equal.

C. Two-way Modulating Control Valves – 2-1/2” and larger

1. Two-way modulating control valves shall be globe-style with equal percentage flow characteristic for water service and linear flow characteristic for steam service.
2. Performance:
 - a. Pressure Rating ANSI 125 or 250
 - b. Close-off Pressure Pump head plus 10%
 - c. Leakage ANSI Class IV
 - d. Temperature Range 34 to 250°F
 - e. Rangeability 100:1
3. Material construction:
 - a. Body Cast Iron
 - b. End Connection ANSI Flanged
 - c. Trim Bronze
 - d. Stem Stainless Steel
4. Input power voltage shall be 24VAC.
5. Control signal to valves shall be via hardwired analog output (0-10 VDC).
6. Valves shall be Siemens Flanged Iron Two-Way Globe Valves, or approved equal.

D. Motorized Isolation Valves – Up to 2”

1. Valve shall be suitable for chilled and hot water service. Isolation valve shall be line-sized, full-port ball valve.

2. Performance:

- a. Pressure Rating 360 psig
- b. Close-off pressure 200 psi
- c. Temperature Range 35 to 250°F

3. Valves shall meet the following material construction specifications:

- a. Body Forged brass
- b. End Connection NPT female
- c. Ball Stainless steel
- d. Stem Stainless steel
- e. Ball Seats Teflon PTFE
- f. Stem Seal EPDM O-rings

- 4. Input power voltage shall be 24VAC.
- 5. Valves shall be two-position (on/off) and provided with open and closed endswitches.
- 6. Valves shall be as manufactured by Belimo, Siemens, or approved equal.

2.23 DAMPER ACTUATORS

- A. Automatic control dampers, smoke dampers, and fire smoke dampers shall be furnished under the Mechanical Section of the specifications.
- B. This section of the specification shall be responsible for furnishing and installing electrical spring-return actuators for all automatic louvered dampers (non-fire and/or smoke-rated dampers). Smoke dampers and combination smoke/fire dampers shall be factory-furnished with electric actuators as part of their UL assemblies.
- C. All electrical wiring (power) for smoke dampers (SDs) and combination fire/smoke dampers (FSDs) shall be furnished and installed by the Electrical contractor at a junction box located at each combination damper. Control wiring shall be by this section.
- D. All electrical wiring (power and control) for all automatic louvered dampers (ALDs) shall be furnished and installed by this section. ALD actuators shall be 24 VAC.
- E. Damper Actuators
 - 1. All automatic louvered damper operators in two-position (open/closed) and modulating (0-10VDC) service shall be 24 or 120 VAC electrically actuated spring-return type. Spring-return running time shall not exceed 20 seconds. Power running time shall not exceed 20 seconds.
 - 2. Smoke dampers and combination fire/smoke damper operators shall be provided with integral 120 VAC actuators as part of their UL-listing
 - 3. Automatic louvered damper operators shall be provided with manual override and external direction of rotation switch and shall be quiet in operation.
 - 4. Operating temperature shall be -22°F to 122°F. Housing shall be NEMA 2.
 - 5. Actuators shall be UL-listed.
- F. Provide a sufficient number of damper actuators to operate single and multiple damper sections smoothly and in unison at the maximum rated static pressure and air velocity, and to provide the close-off torque required to meet damper leakage criteria. Provide auxiliary drive shafts with pillow block bearings and bearing support brackets rigidly attached to the damper frame assembly on damper banks more than one (1) damper section wide.

- G. Actuators shall be installed outside of airstream.
- H. Damper actuators located outdoors shall be equipped with weatherproof enclosure containing O-ring gaskets designed to make motors weatherproof and an internal heater to permit normal operation at minus 22°F.
- I. Damper actuators shall be manufactured by Belimo, Siemens, or approved equal.

PART 3 - EXECUTION

3.1 ELECTRICAL WIRING

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes".
- B. Install building wire and cable according to Division 26 Section "Low Voltage Electrical Power Conductors and Cables".
- C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling"
- D. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
- E. Install exposed cable in EMT raceways.
- F. Install concealed cable in EMT raceways.
- G. Install outdoor cabling in galvanized rigid conduit.
- H. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
- I. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
- J. Number-code or color-code conductors for future identification and service of control system, except local individual room control cable.
- K. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- L. Plenum Rated Cable to be used in accessible locations above ceilings (i.e. open ceilings and drop-ceilings).
- M. Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories.
 - 1. Provide wiring for thermostats, aquastats, and all control and alarm devices for all Sections of the Specifications and wiring for all break-glass stations furnished under this Section.
 - 2. Power for each direct digital control unit, field equipment panel, workstation, server, controller, shall be taken from dedicated power circuits as indicated on the electrical drawings. Power type (normal, emergency, life-safety, etc.) shall match that of the associated mechanical equipment. Wiring and conduit between the electrical junction boxes and all direct digital control units, field equipment cabinets, workstation, server and unitary controllers, etc., shall be furnished and installed by this Section of the Specifications. In addition, this Contractor shall provide a 120 volt, 60 hertz convenience outlet in each controller and panel. Refer to Electrical Drawings for distribution panel locations.
 - 3. Provide conduit and control wiring for devices specified in this Section.
 - 4. Provide control and signal wiring between the DDC system and equipment provided by other Sections such as pumps, variable frequency drives, etc.

5. Provide all control wiring for variable air volume and constant air volume terminal units.
- N. All systems requiring interlock wiring shall be hardwired interlocked and shall not rely on the DDC system to operate (e.g., emergency generator to fuel oil pump interlock, emergency generator damper interlock, etc.). Interlock wiring shall be run in separate conduits from DDC system associated wiring.
- O. All wiring in Mechanical Equipment Rooms, communications or electrical closets shall be in approved raceways (cable tray, conduit, EMT, etc.). Open wiring strung above accessible ceilings shall be plenum-rated cable, bundled together and protected from mechanical damage. Wiring within inaccessible ceilings shall be installed in conduit. Wiring within drywall cavities or enclosures or beneath raised floor construction shall be in conduit. Wiring shall be independently supported from the building structure with bridal rings and clips. The supporting of wiring from mechanical ductwork or piping shall not be acceptable. Provide individual supports for conduit. Where conduit is required, this Contractor shall be responsible for providing all conduit serving DDC system. DDC system wiring (i.e. power, control, communication, sensor or interlock) shall not be installed in conduits, provided under another section of the specification unless noted otherwise. DDC system wiring shall not "share" conduits with any other system unless noted otherwise.
- P. Cables for 120/24 VAC wiring, communications wiring and low-level signal wiring (i.e., 4 - 20 mA analog) shall always be run in separate raceways.
- Q. Low-level signal wiring home runs to local control stations may be by means of multi-pair cables. The number of pairs in such cables shall be uniform throughout the installation, and, in general, there shall be at least 20% spare pairs in each such cable.
- R. 120 VAC circuits used for control and instrumentation shall be taken from panelboards provided under the Electrical Section. The electrical section shall provide junction boxes local to the BMS devices and equipment. Final connection between junction box and BMS devices shall be furnished by this Contractor.
- S. 120 VAC circuits used for control and instrumentation shall be dedicated to the ATC system and shall not be used for any other purposes.
- T. RS-485 Cabling
 1. RS-485 cabling shall be used for BACnet MS/TP networks.
 2. RS-485 shall use low capacitance, 20-24 gauge, twisted shielded pair.
 3. The shields shall be tied together at each device.
 4. The shield shall be grounded at one end only and capped at the other end.
 5. Provide end of line (EOL) termination devices at each end of the RS-485 network or subnetwork run, to match the impedance of the cable, 100 to 120 Ohm.
- U. Ethernet Cabling
 1. Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.
 2. CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.
 3. Solid wire shall be used for long runs, between mechanical rooms and between floors. Stranded cable can be used for patch cables and between panels in the same mechanical room up to 50 feet away.
 4. When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.

V. Fiber-Optic Cabling

1. All fiber optic cabling shall be 50/125-micrometer, laser-optimized (multi-mode OM3/OM4), duplex (2-strand) fiber, optical fiber cable with plenum-rated jackets. Minimum bend radius shall be 7.5mm. Industry standard LC style connectors shall be used. Fiber optic cabling shall be manufactured by Corning.
 2. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
 3. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable andunjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.
 4. All terminations shall be made into a patch panel, designed for such use. Free air terminations with patch panels are prohibited.
- W. Control raceways shall not be hung from electrical raceways or attached to ceiling grid hanger wires.
- X. Percent fill of conduit, EMT or IMC shall not exceed code maximum, regardless of service.

3.2 IDENTIFICATION

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows: CAUTION This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.
- B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows: CAUTION This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.
- C. Control Equipment and Device labeling:
1. Labels and tags shall match the unique identifiers shown on the as-built drawings.
 2. All Enclosures shall be labeled to match the as-built drawing by either control panel name or the names of the DDC controllers inside.
 3. All sensors and actuators not in occupied areas shall be tagged.
 4. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMS flow coefficient.
 5. Duct static pressure taps shall be tagged at the location of the pressure tap.
 6. Each device inside enclosures shall be tagged.
 7. Terminal equipment need only have a tag for the unique terminal number, not for each device. Match the unique number on:
 - a. First, the design drawings, or
 - b. Second, the control as-builts, or

c. Third, the DDC addressing scheme

8. Tags on the terminal units shall be displayed on the Operator Workstation Graphics.

- D. Tags shall be mechanically printed on permanent adhesive backed labeling strips, 12 point height minimum.
- E. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- F. Identification of Wires
 - 1. Tag each wire with a common identifier on each end of the wire, such as in the control panel and at the device termination.
 - 2. Tag each network wire with a common identifier on each end.
 - 3. Tag each 120V power source with the panel and breaker number it is fed by.

G. Identification of Conduits:

- 1. Identify the low voltage conduit runs as BAS conduit, power feeds not included.
- 2. Identify each electric box, junction box, utility box and wiring tray with a blue paint mark or blue permanent adhesive sticker.
- 3. For conduit runs that run more than 8 ft between junction boxes in 1 room, place a blue identifier at least every 8 feet.
- 4. Place a blue identifier on each side of where a conduit passed through a wall or other inaccessible path.
- 5. Identify all BAS communication conduits the same as above.

3.3 GRAPHIC DISPLAY GENERATION

- A. All workstation(s) shall be provided with color graphics. All workstation(s) software shall include a graphical viewing and control environment and definition and construction of dynamic color graphic displays.
- B. Provide a main default screen showing the Basic layout of the building. Each color graphic screen shall have transfer links to allow the building operator to transfer between system associated screens (both forward and backward), as well as a transfer link back to the main default screen.
- C. Graphic Structure: The intent of the graphics is to ensure the operator is always aware of his position within the system and how to logically and intuitively progress through the graphical hierarchy to select desired graphic or other source of information. Provide the operator with the capability of returning to a previous graphic by pointing to a graphic tab then pushing a single button. Program the system to provide a separate color graphic for each piece of equipment monitored or controlled including:
 - 1. Each floor and zone controlled
 - 2. Each equipment unit and terminal
 - 3. Each schedule
 - 4. Each trend
 - 5. Each report
 - 6. Each Graphical Software Program

D. File formats for floor plans shall consist of svg or png. Floor plans shall show the location of

- each space temperature sensor with a dashed line to the associated terminal unit. Display in real time the difference between the space temperature and the current setpoint.
1. Display the cooling %, heating % (if applicable) and current airflow of each terminal unit.
 2. Provide a transfer link for each terminal unit to allow the operator to access the flow graphic for each individual terminal unit. Use a different color to shade the background area for each part of a floor plan graphic served by a different air handling unit.
- E. All control set points shall be easily adjustable from the system's color graphic screen by operators with the proper access level. Each controlled point on the BMS operator workstation color graphic screens shall have the set point indicated along with the actual controlled variable reading (preferred set point on top and actual reading on bottom). All points shall indicate the associated engineering unit. All analog outputs points shall indicate engineering units such as “%-open” or “%-closed” as required by the application. All normally-closed or normally-open points shall indicate the normal position (such as “N.C.” or “N.O.” next to the controlled device).
- F. Provide system color graphics for each HVAC system and for each electrical, plumbing and/or piping system that is monitored and/or controlled by the BMS. Provide scaled floor plans indicating equipment location, service, and system data as required.
- G. Provide color graphic floor plan displays and system schematics for each piece of mechanical equipment, including but not limited to air handling units, chilled water systems and hot water systems to optimize system performance analysis and speed alarm recognition.
- H. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.
- I. The windowing environment of the PC operator workstation(s) shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
1. Graphic generation software shall be provided to allow the user to add, modify or delete system graphic displays via an embedded graphics package.
 2. Provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical symbols.
 3. Graphical displays can be created to represent any logical grouping of system points or calculated data Based upon building function, mechanical system, building layout or any other logical grouping of points which aids the operator in the analysis of the facility.
- J. Provide an automatically updated, dynamic display of the site-specific BMS architecture indicating the status of primary and secondary controllers, PC workstation(s) and networks.
- K. Provide a separate dynamic display page of each HVAC (AHU air handling systems, AC, chiller, cooling tower, fuel oil, etc.), electrical, and/or plumbing system connected to the BMS.
- L. Provide a separate dynamic display page of each piece of terminal equipment (VAV box, fan coil unit, etc.) connected to the BMS.
- M. Graphics shall incorporate all system integration points communicated via hardware or software gateways and/or interfaces. Origin of information shall be transparent to the

- operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.
- N. Each graphic shall have a “BACK” button and a “HOME” or “MAIN” button located in the same location on all graphics.
- O. The operator shall be able to clearly distinguish the difference between the following types of points on a graphic either by color, shape, icon or text label:
1. Real-time sensor reading
 2. Setpoint
 3. Manually set vs. program set Setpoint
 4. Real-time output reading
 5. Manually Overridden or commanded output vs program set output
 6. Status feedback from a piece of equipment vs the output command
- P. When the operator selects a graphic from a menu or a hyperlink, the system shall also make the following adjustments for the operator:
1. Highlight the system name on the system tree
 2. Highlight the controller name on the network tree
 3. Make appear links to additional information associated with the data on the graphic, such as:
 - a. Adjustable modes of operation
 - b. Setpoints
 - c. Alarm statuses
 - d. Trend logs
- Q. Make appear links to additional information associated with the system on the graphic, such as:
1. Controls as-built schematics and wiring diagrams
 2. As-built Sequence of Operation
 3. Mechanical drawings
 4. Electrical drawings
- R. For control loops that have a 4-point setpoint reset schedule, the operator shall have access to adjust the 4 points in the graphics. Provide a separate graphic with the 4 adjustable data points and a line graph with labels vertices showing the scale of the reset ramp. Display the current calculated output setpoint.
- S. Integration graphics shall be representative of personnel standing in front of equipment. The graphics for equipment specified in the Building Systems Integration paragraph shall be representative of the manufacturers’ local display panel and each shall be completely operable from the computer workstation.

3.4 FIELD QUALITY CONTROL

- A. After completion of the installation of work in this section, test, regulate and adjust system equipment, controllers, alarms, sensors, transmitters, switches, relays, automatic control valves, automatic damper motors and related system accessories, and the entire automation system, including interconnections with the building life safety, plumbing, fire protection and

electrical systems, and place these items in complete and satisfactory operating condition. Submit data showing set points and final adjustments of controls.

- B. This Contractor shall provide assistance to the Air and Water Balancer for access to all set point adjustments and calibration requirements. At the completion of the balancing process all air and water set points shall be hardcoded into the default set points for each system.

3.5 SYSTEM ACCEPTANCE TESTING

- A. Prior to full operation, the contractor in the presence of the owner's representative engineer shall perform a complete demonstration and testing of the system operating functions and alarms. This testing shall take place after having satisfactorily met the requirements of shop drawing acceptance. Upon successful completion of system operation, the contractor shall submit a statement in writing stating that the full operation of all systems, functions and alarms has been demonstrated and are operational as well as a listing of all systems, alarms and functions that have been commissioned. All items shall be submitted for review and acceptance to the owner, owner's representative and engineer before final acceptance can take place.
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain HVAC instrumentation and controls. Refer to Division 1 Section "Closeout Procedures" and "Demonstration and Training."

3.6 COMMISSIONING

- A. Engage a factory-authorized service representative to train Owners maintenance personnel to adjust, operate, and maintain HVAC instruments and controls. Refer to Division 1 Section "Demonstration and Training".
- B. The BMS contractor shall submit point to point calibration documentation for all points and functional testing documentation for all control loops showing all control systems have been tested, start-up complete, final PID adjustments complete, dynamic graphics installed on workstation as per owners requirements etc. prior to scheduled demonstration and commissioning.
- C. The BMS contractor shall notify the owner's authorized representative that the BMS is 100% ready for demonstration and commissioning. The BMS contractor shall demonstrate to the authorized representative typical operating functional control loops for 50% of control points and functions.

3.7 TRAINING

- A. Provide sixteen (16) hours of on-site training for four (4) building operators from competent factory authorized personnel. Intent is to provide instruction to operation and maintenance personnel concerning the location, operation and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Construction Manager and owner after submission and approval of formal training plans. All training sessions shall be recorded by the BMS contractor and submitted as part of the operations and maintenance documentation.
- B. Training shall include but not limited to:
 - 1. Explanation of drawings and operations and maintenance manuals.
 - 2. Walk thru of the job to locate control components.
 - 3. Operator workstation and peripherals.

4. Operator control functions including graphic generation and field panel programming.
5. Explanation of adjustment, calibration and replacement procedures.

END OF SECTION

SECTION 232000

HVAC PIPING

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Through Penetration Firestops: Section 078401.

1.02 SUBMITTALS

- A. Product Data:
1. Catalog sheets and specifications indicating manufacturer name, type, applicable reference standard, schedule, or class for specified pipe and fittings.
 2. Material Schedule: Itemize pipe and fitting materials for each specified application in Pipe and Fittings Schedule in Part 3 of this Section. Where optional materials are specified indicate option selected.
- B. Quality Control Submittals:
1. Installers Qualification Data:
 - a. Welder Qualification Data: Copies of certification; include names, home addresses.
 - b. Welding Procedures:
 - 1) Copy of QW-482 "Suggested Format for Welding Procedure Specification (WPS)" for all welders for all weld types.
 - 2) Copy of QW-483 "Suggested Format for Procedure Qualification Record (PQR)" as specified in Welding Quality Assurance below for all weld types.
 - c. Welders' Certificates:
 - 1) Copy of QW-484 "Suggested Format for Manufacturer's Record of Welder or Welding Operator Qualification Tests (WPQ)" for all welders for all weld types.
 - d. Brazer Qualification Data for Refrigerant Piping: State refrigerant piping brazing experience; include names, home addresses and social security numbers of brazers.
 2. Quality Control Submittals (for Hydraulic Press Joints, if used): Copy of hydraulic press fitting manufacturer's printed field inspection procedures for hydraulic press joints in copper tubing.
 3. Manufacturer's Data: Copy of mill certificates, laboratory test and manufacturing reports relating to chemical and physical properties of pipe, fittings, and related materials.
 4. Welding Procedure Submittals: Submit the following:
 - a. Welding Procedure Specifications: Provide for each weld type.
 - 1) Recommended to use ASME Form E00006, QW-482 "Suggested Format for Welding Procedure Specification (WPS)".
 - b. Procedure Qualification Records: Provide for each weld type.

- 1) Recommended to use ASME Form E00007, QW-483
“Suggested Format for Procedure Qualification Record
(PQR)”.
5. Contract Closeout Submittals:
 - a. Copy of Final Hydrostatic Testing Record Log.

1.03 QUALITY ASSURANCE

- A. Qualifications of Welding Procedures, Welders and Welding Operators: Comply with the following:
 1. Section IX ASME Boiler and Pressure Vessel Code, Part QW Welding.
 2. American Welding Society Standard AWS B 2.1.
- B. Welding Procedures:
 1. Record in detail, and qualify the Welding Procedure Specifications for every welding procedure that is proposed to be used for the Project.
 2. Develop procedures for all metals included in the work.
 3. Qualify the procedures for making transition welds between different materials, or between plates or pipes of different wall thickness.
 4. Qualification for each welding procedure shall conform to the requirements of ASME B31.1, and as specified herein.
 5. Describe the method for each system including the number of beads, the volts, the amperes, and the welding rod for various pipe thicknesses and materials.
 6. The welding procedures shall specify end preparation for butt welds including cleaning, alignment, and root openings.
 7. Preheat, interpass temperature control, and postheat treatment of welds shall be as required by approved welding procedures, unless otherwise indicated or specified.
 8. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing acceptable welds.
 9. Welding procedures shall be identified individually and shall be clearly referenced to the type of welding required for this project.
 10. These procedures shall be the same as those used for all pipe welder qualification tests, all shop welds, and all field welds.
 11. Provide procedure qualification records for all proposed Welding Procedure Specifications (WPS).
- C. Welder Qualification:
 1. WPQs:
 - a. Provide welder qualifications for each welder for each weld type.
 - b. Recommended to use ASME Form E00008, QW-484
“Suggested Format for Manufacturer’s Record of Welder or Welding Procedure Qualification Tests (WPQ).”
 2. Perform WPQs under the witness of an independent agency.
 - a. The witness shall be a representative of an independent testing agency, Authorized Inspector, or consultant, any of which must be approved by the National Certified Pipe Welding Bureau.
 - b. The qualifying test segment must be a 2 inch nominal pipe size with wall thickness within range of the WPS.
 - c. Tests position shall be “6G” per ASME Section IX.

3. Evidence of Continuity: Welder qualifications must be current.
 - a. If the qualification test is more than 6 months old, provide record of welding continuity for each welder.
 - b. Record of welding continuity shall show that the welder in question has performed welding to the procedure in question without a 6 month continuous span of inactivity since the date that the welder qualification test was passed for the submitted welding procedure.
 - c. Record of welding continuity shall include, at a minimum, the welder's employer name and address, the date the welder qualification test was passed, and the dates indicating welding continuity including welding procedure for each date.

D. Weld Records:

1. For all welding within the scope of ASME B31.1, submit for approval an administrative procedure for recording, locating, monitoring, and maintaining the quality of all welds to be performed on the project.
 - a. The weld record shall include but not be limited to drawings and schedules identifying location of each weld by individual number, identification of welder who performed each weld by individual welder's name, stamp number, date and WPS used.
2. After achieving qualification, but before being assigned work, each qualified person shall be assigned an identifying number by the Contractor to be used to identify all of his welds.
 - a. A list of qualified persons with their respective numbers shall be submitted and maintained accurately with deletions and additions reported promptly.
3. Upon completing a joint, the welder shall mark the pipe not more than 6 inches from the weld with the identifying number and the last two digits of the year in which the work was performed.
 - a. Make identification marks with a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Director's Representative that do not deform the metal.
 - b. Place identification marks for seam welds adjacent to the welds at 3-foot intervals.
 - c. Identification by die stamps or electric etchers is not acceptable.
 - d. Provide required markers. Substitution of a map of welds with welders' names is not acceptable.
4. Maintain a constantly updated log available to the Director's Representative at all times.

E. Qualifications of Brazers: Comply with the following:

1. Section IX ASME Boiler and Pressure Vessel Code, Part QB Brazing.
2. Certification of brazing operators by recognized authorities which require a qualification test.
3. Refrigerant Piping: The persons performing the brazing and their Supervisors shall be personally experienced in refrigerant piping brazing procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Pipe Storage:
 - 1. Upon the receipt of each shipment of pipe on the job, maintain the pipe marking, and store pipe in accordance with ASTM material specifications, and method of manufacture (seamless, etc.) of each length of pipe.
 - 2. Pipe markings shall be clearly readable at the time of pipe installation.
 - 3. If at the time of its installation, any length of pipe not readily identifiable will be subject to rejection, or arbitrary downgrading by the Director's Representative to the lowest grade which has been received on the job to that date.
 - 4. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, bell and-spigot, and clay pipe.
 - a. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

PART 2 PRODUCTS

2.01 STEEL PIPE AND FITTINGS

- A. Standard Weight Schedule 40 or Extra Heavy Weight Schedule 80, Black or Galvanized Steel: ASTM A 53, Grade B, Type E or S, or ASTM A 135.
 - 1. Applications over 400 psig: ASTM A 106.
- B. Bending, Coiling, Flanging and Other Special Services: ASTM A 53, Grade A, Type E or S, or ASTM A 135.
 - 1. Applications over 400 psig: ASTM A 106.
- C. Grooved End Type: Schedule 40, ASTM A 53, Grade B, Type F for sizes 3/4 inch to 1-1/2 inch, and Type E or S for sizes 2 inch to 24 inch; or ASTM A 135.
- D. Flanges, Welding Neck Type, Same Pressure Rating as Adjoining Pipe: ASME B16.5.
- E. Weld Fittings, Carbon Steel:
 - 1. Butt Welding Type: ASME B16.9.
 - a. Allied Piping Products Co., Inc.'s Branchlets, Type 1 or 2.
 - b. Bonney Forge Corp.'s Weldolets.
 - 2. Socket Welding Type: ASME B16.11.
 - a. Allied Piping Products Co., Inc.'s Branchlets, Type 1 or 2.
 - b. Bonney Forge Corp.'s Thredolets or Sockolets.
- F. Malleable Iron, Steam Pattern Threaded Fittings:
 - 1. 150 lb Class: ASME B16.3.
 - 2. 300 lb Class: ASME B16.3.
- G. Cast Iron Fittings:
 - 1. Drainage Pattern, Threaded: ASME B16.12.
 - 2. Steam Pattern, Threaded: ASME B16.4.

- a. Standard Weight: Class 125.
 - b. Extra Heavy Weight: Class 250.
- 3. Flanged Fittings and Threaded Flanges: ASME B16.1.
 - a. Standard Weight: Class 125.
 - b. Extra Heavy: Class 250.
- H. Unions: Malleable iron, 250 lb class, brass to iron or brass to brass seats.
- I. Couplings: Same material and pressure rating as adjoining pipe, conforming to standards for fittings in such pipe. Use taper tapped threaded type in screwed pipe systems operating in excess of 15 psig.
- J. Nipples: Same material and strength as adjoining pipe, except nipples having a length of less than one inch between threads shall be extra heavy.

2.02 COPPER AND BRASS PIPE, TUBING AND FITTINGS

- A. Copper Tube, Types K, L and M: ASTM B 88.
- B. ACR Tube: ASTM B 280.
- C. Wrot Copper Tube Fittings, Solder Joint: ASME B16.22.
- D. Cast Copper Alloy Tube Fittings, Solder Joint: ASME B16.18.
- E. Chrome Plated Grade A Red Brass Threaded Pipe, Standard Weight: ASTM B 43.
 - 1. Plating: 0.02 mil chromium over 0.2 mil nickel plating, high polish finish.
- F. Chrome Plated Cast Brass Threaded Pipe Fittings, 125 lb Class: ASME B16.15.
 - 1. Plating: 0.02 mil chromium over 0.2 mil nickel plating, high polish finish.
- G. Flared Tube Fittings:
 - 1. Water Tube Type: ASME B16.26.
 - 2. Automotive Tube Type: SAE J512.
 - 3. Refrigerant Tube Type: SAE J513.
- H. Flanges: Conform to the Standards for fittings used in systems.
 - 1. Brazing Flanges: ASME B16.24, hubs modified for brazing ends.
- I. Unions: Cast bronze, 150 lb Class, bronze to bronze seats, threaded or solder joint.

2.03 HYDRAULIC PRESS FITTINGS FOR COPPER TUBING

- A. Acceptable Fittings:
 - 1. ProPress by Viega, 301 N. Main, Wichita, KS 67202, (877) 843-4262, www.viega.com.

- B. Operating Conditions:
 - 1. Maximum Operating Pressure: 200 psi.
 - 2. Operating Temperature Range: 0-250 degrees F.
 - 3. Maximum Test Pressure: 600 psi.
 - 4. Maximum Vacuum: 29.2 inches hg @ 68 degrees F.
- C. Features:
 - 1. Fittings: Copper and copper alloy conforming to material requirements of ASME B16.18 or ASME B16.22.
 - a. Stainless Steel Grip Ring: Adds strength to the joint without collapsing the interior passageway.
 - 2. No flame for soldering required for installation of fittings and valves.
 - 3. Unpressed connections identified during pressure testing when water flows past sealing element.
 - 4. Sealing Elements: Factory installed, EPDM.
 - 5. Fittings that have been pressed can be rotated. If rotated more than 5 degrees, the fitting must be repressed to restore its resistance to rotational movement.
 - 6. Extended fitting end lead allows for twice the retention grip surface, and assists with proper tube alignment.
 - 7. Soldered adapter fittings are not allowed.

2.04 HIGH DENSITY POLYETHYLENE (HDPE) PIPING AND FITTINGS

- A. Pipe: PE3408, ASTM D 2513, unless otherwise required by the serving gas supplier.
- B. Fittings:
 - 1. Butt Fusion Fittings: ASTM D 3261.
 - 2. Socket Fusion Fittings: ASTM D 2683.

2.05 COUPLINGS AND FITTINGS FOR GROOVED END PIPE

- A. Couplings: Grinnell Corp.'s Rigidlok Fig. 7401, or Victaulic Co.'s Zero-Flex Style 07, having minimum pressure rating of:
 - 1. 750 psi from 1-1/2 inch to 4 inch.
 - 2. 700 psi for 6 inch.
 - 3. 600 psi for 8 inch.
- B. Couplings: Gustin-Bacon Inc.'s No. 100 Gruvagrips, or Victaulic Co.'s Style 77, having pressure rating of:
 - 1. 1000 psi for 3/4 inch to 6 inch.
 - 2. 800 psi for 8 inch to 12 inch.
 - 3. 300 psi for 14 inch to 24 inch.
- C. Fittings: By same manufacturer as couplings, having pressure ratings equal to or greater than couplings. Comply with the following standards:
 - 1. Steel: ASTM A 53 or A106, Grade B.
 - 2. Malleable Iron: ASTM A 47.
 - 3. Ductile Iron: ASTM A 536.

2.06 FIBERGLASS REINFORCED PLASTIC PIPING (FRP)

- A. Condenser Water Applications:
 - 1. Maximum Operating Conditions: 210 degrees at 150 psig (cyclic).
 - 2. Conforming to ASTM D 2310, Classification RTRP-11; and ASTM D 2996, Classification RTRP-11.
 - 3. Pipe: Filament wound using continuous glass filaments and epoxy resins; Series 3000A by Ameron, or Red Thread II Series by NOV Fiberglass Systems.
 - 4. Fittings: Filament wound or compression molded bell and spigot epoxy fittings and flanges as recommended and furnished by the pipe manufacturer for the intended service; Series 3000A by Ameron, or Red Thread II Series by NOV Fiberglass Systems.
 - 5. Epoxy Adhesive: As recommended and furnished by the pipe and fitting manufacturer for the intended service.
- B. Condensate Return Applications:
 - 1. Maximum Operating Conditions: 250 degrees F at 125 psig.
 - 2. Conforming to ASTM D 2310, Classification RTRP-11; ASTM D 2996, Classification RTRP-11, and MIL-P-28584 B.
 - 3. Pipe: Filament wound using continuous glass filaments, epoxy resin, and minimum 0.020 inch reinforced liner; Series 2000 MP by Ameron, or Green Thread CR Series by NOV Fiberglass Systems.
 - 4. Fittings: Filament wound or compression molded bell and spigot epoxy fittings and flanges; as recommended and furnished by the pipe manufacturer for the intended service; Series 2000 MP by Ameron, or Green Thread CR Series by NOV Fiberglass Systems.
 - 5. Epoxy Adhesive: As recommended and furnished by the pipe and fitting manufacturer for the intended service.

2.07 JOINING AND SEALANT MATERIALS

- A. Thread Sealant:
 - 1. LA-CO Industries', Slic-Tite Paste with Teflon.
 - 2. Loctite Corp.'s No. 565 Thread Sealant.
 - 3. Thread sealants for potable water shall be NSF approved.
- B. Thread Sealant (Natural Gas Piping): Rectorseal Corp.'s T Plus 2 non-hardening pipe dope with teflon.
- C. Fuel Resistant Thread Sealant:
 - 1. Rectorseal Corp.'s Rectorseal No. 5.
 - 2. EMCO Wheaton Inc.'s Joint Seal.
- D. Solder: Solid wire type conforming to the following:
 - 1. Type 2: Lead-free tin-silver solder (ASTM B 32 Alloy Grade Sn 96); All-State Welding Products Inc.'s 430, Engelhard Corp.'s Silvacbrite, or J.W. Harris Co. Inc.'s Stay-Brite.

2. Type 3: Lead-free tin-silver solder (ASTM B 32 Alloy Grade E, AC, or HB); Engelhard Corp.'s Silvabrite 100, Federated Fry Metals' Aqua Clean, or J.W. Harris Co. Inc.'s Stay-Safe Bridgit.
- E. Soldering Flux for Soldered Joints: All-State Welding Products Inc.'s Duzall, Engelhard Corp.'s General Purpose Liquid or Paste, Federated Fry Metals' Water Flow 2000, or J.W. Harris Co. Inc.'s Stay-Clean.
- F. Brazing Alloys:
 1. Type 1: AWS A5.8, Class BCup-5, for brazing copper to brass, bronze, or copper; Engelhard's Silvaloy 15, J.W. Harris Co. Inc.'s Stay-Silv 15, and Handy & Harman's Sil-Fos.
 2. Type 2: AWS A5.8, Class BAg-7, for brazing copper to steel or stainless steel; Engelhard's Silvaloy-56T, J.W. Harris Co. Inc.'s Safety-Silv 56, and Handy & Harman's Braze 560.
- G. Brazing Flux: AWS Type FB3A; Handy & Harman's Handy Flux or J.W. Harris Co. Inc.'s Stay-Silv.
- H. Electrodes and Welding Rods:
 1. Electrodes for Use in Arc Welding: Heavily coated, not larger than 3/16 inch diameter exclusive of coating, unless otherwise approved.
 2. Welding Rods: Free flowing when fused, so as to avoid excessive puddling.
 3. Electrodes for Welding Stainless Steels: Coated and used with reverse polarity.
 4. Filler material shall conform to the appropriate AWS-ASTM specification.
- I. Flange Gasket Material:
 1. For Use With Cold Water or Chilled Water: 1/16 inch thick rubber.
 2. For Use With Hot Water, or Air: Waterproofed non-asbestos mineral or ceramic fiber, or a combination of metal and waterproofed non-asbestos mineral or ceramic fiber, designed for the temperature and pressures of the piping systems in which installed.
 3. For use with Steam, Feedwater, Blow-Off and Natural Gas: Spirally wound, Type 304 stainless steel with non-asbestos filler material, and carbon steel outer ring.
 - a. Maximum Operating Pressure: 600 psi at 700 degrees F.
 - b. Thickness: 1/16 thick, conforming to the flange face on which they are used.
 - c. Acceptable Gaskets: Flexitallic Style CG with Flexite Super Filler by Flexitallic Inc., Deer Park, TX; (281) 479-3491.
 4. For use with Fuel Oil: Non-asbestos, compressed sheet, nitrile binder.
 - a. Maximum Operating Pressure: 600 psi at 700 degrees F.
 - b. Thickness: 1/16 thick, conforming to the flange face on which they are used.
 - c. Acceptable Manufacturers: Sepco, or Sur-Seal.
- J. Flange Bolts, Washers and Nuts
 1. Bolts: High strength, ASTM A 193 B7.

2. Washers: ASTM F436 Structural Type 1 hardened steel flat hot dipped galvanized.
 3. Nuts: ASTM A194 2H.
- K. Gaskets For Use With Grooved End Pipe and Fittings: Type and materials as recommended and furnished by the fitting manufacturer, for the service of piping system in which installed.
- L. Anti-Seize Lubricant: Bostik Inc.'s Never Seez or Dow Corning Corp.'s Molykote 1000.
- M. Corrosion Protective Tape System: 3M Co., St. Paul, MN.
1. Tape: Scotchrap 50 or 51.
 2. Primer: Scotchrap pipe primer.
 3. Putty (if required): Strip Caulk insulation putty.

2.08 PACKING MATERIALS FOR BUILDING CONSTRUCTION PENETRATIONS

- A. Oiled Oakum: Manufactured by Nupak of New Orleans, Inc., 931 Daniel St., Kenner, LA 70062, (504)466-1484.
- B. Mechanical Modular Seals: Thunderline Corp.'s Link Seal wall and floor seals designed for the service of piping system in which installed.

2.09 DIELECTRIC CONNECTORS

- A. Dielectric Fitting: Bronze ball valve with end connections and pressure rating to match associated piping.
1. Nipples with inert non-corrosive thermoplastic linings are not acceptable.
- B. Flange Electrical Insulation Kit: Consisting of dielectric sleeves and washers, and dielectric gasket.
1. Water Applications:
 - a. Heating Hot Water: Rated 150 psi at 250 degrees F: ANSI Class 300, full faced durlon gasket with bolt holes, double durlon washers, and durabla sleeves; Model 300 by APS, Lafayette, LA 70596, (337) 233-6116.
 - b. Potable Water: Rated 150 psi at 250 degrees F: ANSI Class 150, full faced neoprene gasket with bolt holes, double phenolic washers, and mylar sleeves; Model 150 by APS, Lafayette, LA 70596, (337) 233-6116.
 2. Steam Applications:
 - a. Rated 200 psi at 388 degrees F: ANSI Class 300, full faced durlon gasket with bolt holes, double pyrox washers, and pyrox sleeves; Model 300 by APS, Lafayette, LA 70596, (337) 233-6116.

2.10 PIPE SLEEVES

- A. Type A: Schedule 40 steel pipe.
- B. Type B: No. 16 gage galvanized sheet steel.

- C. Type C: Schedule 40 steel pipe with 1/4 inch steel collar continuously welded to pipe sleeve. Size steel collars as required to span a minimum of one cell or corrugation, on all sides of the rough opening thru the metal deck.
- D. Type D: No. 16 gage galvanized sheet steel with 16 gage sheet steel metal collar rigidly secured to sleeve. Size metal collars as required to span a minimum of one cell or corrugation, on all sides of the rough opening thru the metal deck.

2.11 FLOOR, WALL AND CEILING PLATES

- A. Cast Brass: Solid type with polished chrome plated finish, and set screw.
 - 1. Series Z89 by Zurn, 929 Riverside Drive, Grosvonordale, CT 06255, (800) 243-1830.
 - 2. Model 127XXXX by Maguire Mfg., Cheshire CT 06410, (203) 699-1801.
- B. Stamped Steel: Split type, polished chrome plated finish, with set screw.
 - a. Figures 2 and 13 by Anvil International, Portsmouth, NH 03802, (603) 422-8000.
- C. Cast Iron or Malleable Iron : Solid type, galvanized finish, with set screw:
 - 1. Model 395 by Anvil International, Portsmouth, NH 03802, (603) 422-8000.
 - 2. Model 900-016XX by Landsdale International, Westville, NJ 08093, (800) 908-0523.

2.12 FIBERGLASS REINFORCED PLASTIC PIPING (FRP)

- A. UL 971 listed for conveying flammable petroleum products underground, for all products tested by UL.
- B. Conform to ASTM D 2310, Classification RTRP-11; and ASTM D 2996, Classification RTRP-11.
- C. Fittings and Joining Materials: Comply with the FRP Manufacturer's recommendations for the intended service.

2.13 FLEXIBLE CONTAINMENT PIPING AND FITTINGS

- A. Acceptable Piping:
 - 1. Single wall corrugated, crush and puncture resistant, high density polyethylene; OPW FlexWorks Access Pipe
 - 2. Multiple layer nylon 12; APT's XP SC.
- B. Fittings, Seals, and Joining Materials: Comply with the pipe manufacturer's recommendations.

2.14 FLEXIBLE DOUBLE WALL PRIMARY PIPING

- A. Acceptable Piping:

1. PVDF inner barrier layer, tie layer, PVDF outer barrier layer, PVDF secondary jacket, with stainless steel swage coupler; OPW FlexWorks Primary Pipe.
2. Multi layer nylon 12 inner layer with stainless swage couplers or clamshell fittings; APT's XP-SC.

B. UL 971 listed for underground service with petroleum products.

2.15 FLEXIBLE COUPLINGS FOR CONTAINMENT PIPING

- A. Type: Flexible PVC or nylon12 construction with stainless steel hose clamps, and sized to match secondary containment pipe diameter.

2.16 FLEXIBLE CONNECTIONS

- A. Underground Application:
1. Acceptable Companies:
 - a. Titeflex Inc., Springfield, MA.
 - b. Flex-ing, Sherman, TX.
 2. Features:
 - a. Construction: Stainless steel innercore covered with braided type 304 stainless steel outer jacket.
 - b. UL listed for underground fuel storage tank systems.
 - c. Connections for unleaded gasoline systems shall be fire rated.
 - d. Permanently crimped stainless steel collars with one threaded end and one threaded swivel end.
- B. Underground or Above Ground Application:
1. Acceptable Companies:
 - a. Titeflex Inc., Springfield, MA.
 - b. Flex-ing, Sherman, TX.
 2. Features:
 - a. Construction: Convuluted, Type 321 stainless steel inner core, minimum .012 inch wall thickness covered with braided Type 304 stainless steel outer jacket.
 - b. UL listed for above ground and underground use.
 - c. Connections for unleaded gasoline systems shall be fire rated.
 - d. Factory installed male swivel on one end.

2.17 FLEXIBLE CONNECTION ISOLATION JACKET

- A. Type: High density polyethylene flexible tube with Buna-N rubber compression seals, air valve stem, and stainless steel clamps; Titeflex Inc.'s Model 111466-1, or Flexing Model Yellow Jacket.

2.18 TEST BOOTS

- A. Test boots complete with stainless steel clamps, and air valve stem for tightness testing.
1. Flexible Nitrile Rubber: OPW TBA series, or APT STB or STB-SW series.

2. Flexible Pelethane (Filled with Petroseal Paste): Blue-Line Model Quick Fit series.

2.19 TRANSITION ASSEMBLY

- A. The unit shall include all parts required to interface and seal a rigid 1-inch supply pipe and a rigid 3/4-inch return pipe with flexible underground piping of the same size enclosed in a nominal 4-inch dia. flexible containment pipe; OPW FlexWorks PTA-4175, or APT Model TSL, TST, or TSB.

2.20 SUMP WALL SEAL ASSEMBLY – 2 INCH PRIMARY PIPE, 4 INCH CONTAINMENT PIPE

- A. Seal assembly complete with stainless steel clamps, and air valve stem for tightness testing.
 1. Flexible Nitrile Rubber: OPW FlexWorks Model DEB-4020, or APT Model DEB-200-DA.
 2. Flexible Pelethane (Filled with Petroseal Paste): Blue-Line Model Quick Fit series.

2.21 SUMP WALL SEAL ASSEMBLY – 1-1/2 INCH PRIMARY PIPE, 4 INCH CONTAINMENT PIPE

- A. Seal assembly complete with stainless steel clamps, and air valve stem for tightness testing.
 1. Flexible Nitrile Rubber: OPW FlexWorks Model DEB-4015, or APT Model WTS-400 with DEB-150-DA.
 2. Flexible Pelethane (Filled with Petroseal Paste): Blue-Line Model Quick Fit series.

2.22 SUMP WALL SEAL ASSEMBLY – 1 INCH AND 3/4 INCH PRIMARY PIPE, 4 INCH CONTAINMENT PIPE

- A. Seal assembly complete with stainless steel clamps, and air valve stem for tightness testing;
 1. Flexible Nitrile Rubber: OPW FlexWorks Model DEB-400 seal w/ TBA-4175A test boot, or APT Model DDB-075-SC.
 2. Flexible Pelethane (Filled with Petroseal Paste): Blue-Line Model Quick Fit series.

2.23 SUMP WALL SEAL ASSEMBLY- 3/4 OR 1 INCH RIGID ELECTRICAL CONDUIT

- A. Seal assembly complete with stainless steel clamps, and air valve stem for tightness testing;
 1. Flexible Nitrile Rubber: OPW FlexWorks Model DEB-0751, or APT Model FEB-075D.
 2. Flexible Pelethane (Filled with Petroseal Paste): Blue-Line Model Quick Fit series.

2.24 FLEXIBLE DOUBLE WALL ABOVEGROUND PIPING

- A. Type: FLEXWELL Model HL32 (1-1/4 inch) and HL40 (1-1/2 inch) by Brugg Pipe Systems, 25 Anderson Road, Rome, GA 30162, (706), pipesystems@brugg.com.
- B. Features:
 - 1. Primary Pipe: Type 316L/Ti stainless steel.
 - 2. Secondary Pipe: Type 316L/Ti stainless steel.
 - 3. Corrosion Protection Jacket: LDPE.
 - 4. Compression fittings and sump seals.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Install piping at approximate locations indicated, and at maximum height.
- B. Install piping clear of door swings, and above sash heads.
- C. Make allowances for expansion and contraction.
- D. Allow for a minimum of one inch free air space around pipe or pipe covering, unless otherwise specified.
- E. Install vertical piping plumb.
- F. Use fittings for offsets and direction changes, except for Type K soft annealed copper tube.
- G. Cut pipe and tubing ends square; ream before joining.
- H. Threading: Use American Standard Taper Pipe Thread Dies.
 - 1. Thread brass pipe with special threading dies.
- I. Make final connections to equipment with unions, flanges, or mechanical type joint couplings.

3.02 STEAM PIPING SYSTEMS

- A. Install to permit complete drainage.
- B. Pitch:
 - 1. Pitch horizontal steam mains, return mains and branches downward, 1/4 inch per 10 feet in direction of flow.
 - 2. Pitch steam runouts and connections to risers upward, 3/16 inch per foot in direction of flow.
 - 3. Pitch return branches and runouts downward, 1/4 inch per 10 feet in direction of flow.

- C. Use eccentric reducers flat on bottom in horizontal piping.
- D. Install drip legs with traps at low points, ends of mains, bottoms of risers and ahead of pressure regulators and control valves.
- E. Size short vertical supply and return connections, from horizontal runouts to radiator traps and valves, same size as trap or valve.

3.03 WATER AND PROPYLENE GLYCOL PIPING SYSTEMS

- A. Pitch:
 - 1. Pitch horizontal piping 1/8 inch per 10 feet in direction indicated on drawings. When direction of flow is not indicated, pitch supply piping up in direction of flow and return piping downward in direction of flow.
 - 2. Pitch single pipe systems up in direction of flow 1/8 inch per 10 feet.
- B. Air Vents: Install air vents at locations indicated on the drawings, and at each high point in system. Use manually operated air vents, unless otherwise indicated.
- C. Drains:
 - 1. Install piping to be completely drainable. Provide drains at low points, consisting of a 1/2 inch valve with a hose bibb connection, and at the following locations and equipment:
 - a. In each section of piping separated by valves.
 - b. For each riser, where riser or runout to riser has a valve installed.
 - c. For each heating cooling unit, having valves in supply and return connections.
 - d. In low point of piping to each down fed convector or radiator.
- D. Runouts: Connect runouts to upfeed risers to top of mains, and runouts to downfeed risers to bottom of mains.

3.04 NATURAL GAS PIPING SYSTEMS

- A. Install in compliance with the National Fuel Gas Code-NFPA 54 and as required by the serving gas supplier.
- B. Use non-hardening pipe dope on threads. Do not use thread seal tape.

3.05 LIQUEFIED PETROLEUM GAS PIPING SYSTEMS

- A. Install in compliance with NFPA 58, Standard for Storage and Handling of Liquefied Petroleum Gases, and as required by serving gas supplier.
- B. Use non-hardening pipe dope on threads. Do not use thread seal tape.

3.06 FUEL OIL SYSTEM PIPING

- A. Underground Piping:

1. Pitch horizontal piping upward from containment sump 1/8 inch per foot minimum.
 2. Install copper tubing in continuous lengths from containment sump to fuel burning apparatus.
 - a. Exception: Where black steel piping is used for fuel oil supply, return, and gage piping inside building, run copper tubing in continuous lengths from containment sump to one foot beyond interior surface of exterior building wall.
 3. Run fuel oil supply, return, and gage piping in single containment pipe from containment sump to one foot beyond interior surface of exterior building wall.
 - a. Exception: Where flexible primary piping is used for fuel oil supply and return, run copper tubing gage line in polyethylene (PE) piping from containment sump to one foot beyond interior surface of exterior building wall.
 4. Install flexible primary piping and/or Type K copper tubing in continuous lengths from containment sump to one foot beyond interior surface of exterior building wall.
- B. Piping Inside Building:
1. Pitch horizontal piping downward from wall 1/8 inch per foot minimum.
 2. Where copper tubing is used, install in continuous lengths to burning apparatus and gage display.
- C. Above Ground Piping (Exterior to Building):
1. Pitch horizontal piping from tank 1/8 inch per foot minimum.
 2. Run piping from tank to one foot beyond interior surface of exterior building wall.
 3. At interior surface of exterior building wall, provide required adapters.
 - a. Run fuel oil supply and return piping to burning apparatus.
 - b. Run gage piping to gage display.
 4. Protection Pipe (when directed): Run above ground piping in galvanized steel protection pipe, and run from tank to interior surface of exterior building wall, or to connection with underground piping, or equipment.
 5. Containment Pipe: Run above ground piping in flexible double wall aboveground pipe, and run from tank to interior surface of exterior building wall, or to connection with underground piping, or equipment.

3.07 PIPE JOINT MAKE-UP

- A. Threaded Joint: Make up joint with a pipe thread compound applied in accordance with the manufacturer's printed application instructions for the intended service.
1. Chrome Plated Brass Piping: Tighten joint with strap or Parmalee wrench; do not mar pipe finish. Install piping so that no threads are visible.
- B. Soldered Joint: Thoroughly clean tube end and inside of fitting with emery cloth, sand cloth, or wire brush. Apply flux to the pre-cleaned surfaces. Install fitting, heat to soldering temperature, and join the metals with type solder specified. Remove residue.

- C. Flanged Pipe Joint:
 - 1. Install threaded companion flanges on steel pipe; flanges on galvanized pipe are not required to be galvanized.
 - 2. Provide a gasket for each joint.
 - a. Hot Water Pipe Gasket: Coat with a thin film of oil before making up joint.
 - b. Compressed, Control, and Instrument Air Pipe Gasket: Coat with a thin film of oil before making up joint.
 - 3. Flange Bolt Installation:
 - a. Clean and coat nuts, bolt threads and washers with anti-seize lubricant before making up joint.
 - b. With each bolt; one hardened steel washer is required under the nut.
 - c. With each stud; one hardened steel washer is required under the nut at each end.
 - d. Torque Requirements: Stress bolts to 30,000 psi.
 - e. Check torque with a calibrated breaking action torque wrench on the final torque round.
 - f. Bolts shall be cold and hot torqued.
 - g. Torque Pattern: Cross or star pattern with at least four passes. Limit each pass to 30 percent of full torque increases.
 - h. Hot torque: Re-torque the flange bolts with the system at normal operating pressure, and operating temperature for minimum of 12 to 15 hours.
 - 4. Coat bolt threads and nuts with anti-seize lubricant before making up joint.
- D. Grooved Pipe Joint: Roll groove pipe ends, make up joint with grooved end fittings and couplings, in conformance with the manufacturer's printed installation instructions.
 - 1. Cut grooved end piping is not acceptable.
- E. Welded Pipe Joint:
 - 1. General:
 - a. Weld pipe joints only when ambient temperature is above 0 degree F where possible.
 - b. Bevel pipe ends at a 37.5 degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
 - c. Use pipe clamps or tack-weld joints with 1 inch long welds; 4 welds for pipe sizes to 10 inches, 8 welds for pipe sizes 12 inches to 20 inches.
 - d. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass.
 - e. Eliminate valleys at center and edges of each weld.
 - f. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
 - g. Do not weld-out piping system imperfections by tack-welding procedures. Refabricate as required to comply with requirements.

- h. If piping component ends are bored, such boring shall not result in the finished wall thickness after welding less than the minimum design thickness.
 - i. Align the inside diameters of piping components to be butt-welded as accurately as is practicable within existing commercial tolerances on diameters, wall thickness and out of roundness.
 - j. Preserve alignment during welding. The internal misalignment of the ends to be joined shall not exceed 0.05 inch.
- 2. Welding Processes:
 - a. All welding on metal piping systems shall be performed using qualified welding procedures and qualified welders and welding operators in accordance with Section IX of the ASME Boiler and Pressure Vessel Code.
 - b. All welding shall be performed by a process that is compatible with the work being welded and the working conditions. Shielded metal-arc welding (SMAW) shall not be used on work less than 3/16 inch thick.
 - c. Welding shall be performed by using only one of the following processes:
 - 1) Shielded Metal Arc Welding (SMAW), also know as “Stick” Welding.
 - 2) Gas Tungsten Arc Welding (GTAW), also known as TIG and Heliarc Welding.
 - 3) Submerged Arc Welding (SAW).
 - d. Where a specific welding process is called for in the piping group, it shall govern.
 - e. All stainless steel work less than 3/16 inch thick shall be welded by the gas tungsten-arc (GTAW) process with the back side purged with argon. Work thicker than 3/16 inch shall have a root pass by the GTAW Process with the back purged with argon and the balance of the weld may be completed by SMAW Process or any other suitable process.
- 3. Welding Grooves:
 - a. Bevel the ends of steel pipe and fittings to be erected with butt welded joints to form welding grooves in accordance with ANSI B16.25, except where otherwise noted herein, or on the Contract Drawings.
 - b. Bevel welding grooves for butt welded joints in pipe of unequal wall thickness in accordance with ASME Code for Pressure Piping B31.1 - latest edition, latest revision and section that is applicable.
- 4. Backing Rings: Backing rings or consumable inserts are not acceptable.
- 5. Cleaning of Welding: Completely remove all slag or flux remaining on the bead of welding before laying down the next successive bead and at the completion of the weld.
 - a. Wire brush all completed welds a minimum of 2 inches on both sides and coated with one coat of high temperature (minimum rated 500 deg. F) primer prior to being insulated.
- 6. Preheating of Welded Joints: Pipe adjacent to joints before and during welding shall be preheated by any suitable method in accordance with

- the qualified welding procedure, and in all cases shall be in accordance with ASME B31.1, Paragraph 131.
7. Weld Quality:
 - a. All welds shall have full penetration and complete fusion with a minimum of weld metal protruding on the inside of the pipe.
 - b. The finished weld contour shall be uniform, with the toe or edge of the weld merging smoothly into the base material.
 - c. Butt welds shall have a slight reinforcement build-up gradually from the toe or edge toward the center of the weld.
 - d. The limitation on butt weld reinforcement shall be in accordance with ASME B31.1, Table 127.4.2 and shall apply separately to both inside and outside surfaces of the joint.
 - e. Fillet welds may be slightly concave on the furnished surface.
 8. Identification of Welders:
 - a. Upon completing a joint, the welder shall mark the pipe not more than 6 inches from the weld with the identifying number and the last two digits of the year in which the work was performed.
 - b. Make Identification marks with a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Director's Representative that do not deform the metal.
 - c. Place identification marks for seam welds adjacent to the welds at 3-foot intervals.
 - d. Identification by die stamps or electric etchers is not acceptable.
 - e. Provide required markers. Substitution of a map of welds with welders' names is not acceptable.
 9. Postheat Treatment of Welded Joints In Carbon and Ferritic Alloy Steel Pipe:
 - a. Postheat treatment of welded joints in carbon and ferritic alloy steel piping shall be in accordance with ASME B31.1, as specified in the piping group, or on the Contract Drawings, except the cooling rate for stress relieving shall not exceed 200 degrees F per hour down to 600 degrees F.
 - 1) In each case, the temperature given is a minimum and where a higher temperature is called for in the welding procedure, the welding procedure shall govern.
 - b. Perform stress relieving by one of the following methods:
 - 1) Electrical resistance or induction coil heating is the preferred method for field use.
 - a) Record the temperature by pyrometer from the start of the heating operation until 600 degrees F. is reached during cooling.
 - 2) The gas, natural or liquid petroleum, torch stress relieving procedure may be used only where approved by Director's Representative.
 - a) Maintain temperature record from the start of the heating operation until 600 degrees F. is reached during cooling.
 - b) Place two measuring thermocouples 180 degrees apart at the centerline of the weld and two measuring thermocouples each placed 90

degrees away from the centerline thermocouples
at a distance from the centerline of the weld
equal to three times the wall thickness.

- 3 Furnace postheat treatment may be employed when desirable to treat several welded or formed assemblies simultaneously.
 - a) Temperature range, heating conditions, holding time, and cooling conditions shall be as outlined above but shall satisfy the requirements for the thickest section, etc. of the load.
 - b) When this method is used, adequately support pipe and pipe assemblies to minimize distortion.
10. Socket Welding Joints:
 - a. Where socket welding valves or fittings are used, space pipe with a minimum of 1/16 inch clearance between the end of the pipe and the socket so that no stresses will be imparted to the weld due to "bottoming" of the pipe in the socket.
 - b. The fit between the socket and the pipe shall conform to applicable standards for socket weld fittings and in no case shall the inside diameter of the socket exceed the outside diameter of the pipe by more than 0.075 inches.
- F. Brazed Joint: Thoroughly clean tube end and inside of fitting with emery cloth, sand cloth, or wire brush. Apply flux to the pre-cleaned surfaces. Install fitting, heat to brazing temperature, and join the metals with brazing alloy. Remove residue.
- G. Mechanical Joint: Make up joint in conformance with the manufacturer's printed installation instructions, with particular reference to tightening of bolts.
- H. Reinforced Thermosetting Resin Pipe Joint: Follow the manufacturer's printed installation instructions.
- I. Polyethylene Containment Pipe Joint: Follow manufacturer's printed installation instructions.
- K. Fiberglass Reinforced Plastic Pipe Joint (FRP): Follow manufacturer's printed installation instructions.
- L. High Density Polyethylene Pipe Joint (HDPE): Follow manufacturer's printed installation instructions.
- M. Polyethylene Pipe Joint (PE): Follow manufacturer's printed installation instructions.
- N. Refrigerant Pipe Joint:
 1. Hard Drawn Tubing, Brazed Joint: Make up joint with appropriate type of brazing alloy. Sweep piping interior with dry nitrogen at a rate of 1 to 3 cfm during brazing operation.

2. Hard Drawn Tubing, Soldered Joint: Solder joints with Type 2 solder at valves, controls, and other locations where brazing temperatures could cause damage.
 3. Soft Annealed Tubing Joint: Make up joints with refrigerant tube type flared fittings. Do not bend tubing at a radius less than 5 times the tube diameter.
- O. Hydraulic Pressed Joint: Follow manufacturer's printed installation instructions.
- P. Dissimilar Pipe Joint:
1. Joining Bell and Spigot and Threaded Pipe: Install a half coupling on the pipe or tube end to form a spigot, and caulk into the cast iron bell.
 2. Joining Dissimilar Threaded Piping: Make up connection with a threaded coupling or with companion flanges.
 3. Joining Dissimilar Non-Threaded Piping: Make up connection with adapters recommended by the manufacturers of the piping to be joined.
 4. Joining Galvanized Steel Pipe and Brass Pipe or Copper Tubing: Make up joint with a dielectric connector.
 5. Joining FRP and Threaded Pipe: Make up connection with adapters as recommended by manufacturers of piping being joined.

3.08 PIPING PENETRATIONS

- A. Sleeve Schedule: Unless otherwise shown, comply with the following schedule for the type of sleeve to be used where piping penetrates wall, floor, or roof construction:

<u>CONSTRUCTION</u>	<u>SLEEVE TYPE</u>
1. Frame construction.	None Required
2. Foundation walls.	A*
3. Non-waterproof interior walls.	B*
4. Non-waterproof interior floors on metal decks.	D*
5. Non-waterproof interior floors not on metal decks.	B*
6. Floors not on grade having a floor drain.	A
7. Floors over mechanical equipment, steam service, machine, and boiler rooms.	A
8. Floors finished or to be finished with latex composition or terrazzo, and on metal decks.	D*
9. Floors finished or to be finished with latex composition or terrazzo, and not on metal decks.	A
10. Earth supported concrete floors.	None Required
11. Exterior concrete slabs on grade.	A
12. Fixtures with floor outlet waste piping.	None Required
13. Metal roof decks.	C
14. Non-metal roof decks.	A
15. Waterproof floors on metal decks.	D

- | | | |
|-----|---------------------------------------|---|
| 16. | Waterproof floors not on metal decks. | A |
| 17. | Waterproof walls. | A |

*Core drilling is permissible in lieu of sleeves where marked with asterisks.

B. Diameter of Sleeves and Core Drilled Holes:

1. Unless otherwise specified, size holes thru floors and walls in accordance with the through penetration fire stopping system being used.
2. Size holes thru exterior walls or waterproofed walls above inside earth or finished floors, and exterior concrete slabs in accordance with the following:
 - a. Uninsulated (Bare) Pipe: Inside diameter of sleeve or core drilled hole 1/2 inch greater than outside diameter of pipe, unless otherwise specified.
 - b. Insulated Pipe: Inside diameter of sleeve or core drilled hole 1/2 inch greater than outside diameter of insulation, unless otherwise specified.
 - c. Mechanical Modular Seals: Size holes in accordance with the manufacturer's recommendations.

C. Length of Sleeves (except as shown otherwise on Drawings):

1. Walls and Partitions: Equal in length to total finished thickness of wall or partition.
2. Floors, Finished: Equal in length to total finished thickness of floor and extending 1/2 inch above the finished floor level, except as follows:
 - a. In furred spaces at exterior walls, extend sleeve one inch above the finished floor level.
3. Exterior Concrete Slabs: Equal in length to total thickness of slab and extending 1/2 inch above the concrete slab.
4. Roofs: Equal in length to the total thickness of roof construction, including insulation and roofing materials, and extending one inch above the finished roof level.

D. Packing of Sleeves and Core Drilled Holes:

1. Unless otherwise specified, pack sleeves or cored drilled holes in accordance with Section 078400 - FIRESTOPPING.
2. Pack sleeves in exterior walls or waterproofed walls above inside earth or finished floors with oakum to within 1/2 inch of each wall face, and finish both sides with sealant. See Section 079200.
 - a. Sealant Types:
 - 1) Piping Conveying Materials up to 140 degrees F other than Fuel Oil System Piping: Type 1C (one part).
 - 2) Piping Conveying Materials over 140 degrees F: Type 4.
 - 3) Fuel Oil System Piping: Type 1C (2 part).
 - b. Mechanical modular seals may be used in lieu of packing and sealant for sleeves and core drilled holes.
3. Pack sleeves in exterior concrete slabs with oakum to full depth, and within 1/2 inch of top of sleeve and finish the remainder with sealant. See Section 079200.
 - a. Sealant Types:

- 1) Piping Conveying Materials up to 140 degrees F other than Fuel Oil System Piping: Type 1C (one part).
 - 2) Piping Conveying Materials over 140 degrees F: Type 4.
 - 3) Fuel Oil System Piping: Type 1C (2 part).
- b. Mechanical modular seals may be used in lieu of packing and sealant for sleeves and core drilled holes.
- E. Weld metal collars of Type C and D sleeves to the upper surface of the metal deck. Seal voids under the metal collar as recommended by the manufacturer of the metal deck.

3.09 FLOOR, WALL AND CEILING PLATES

- A. Install plates for exposed uninsulated piping passing thru floors, walls, ceilings, and exterior concrete slabs as follows:
1. In Finished Spaces:
 - a. Piping 4 Inch Size and Smaller: Solid or split, chrome plated cast brass.
 - b. Piping Over 4 Inch Size: Split, chrome plated cast brass.
 2. Unfinished Spaces (Including Exterior Concrete Slabs): Solid, unplated cast iron.
 3. Fasten plates with set screws.
 4. Plates are not required in pipe shafts or furred spaces.

3.10 PIPE AND FITTING SCHEDULE

- A. Abbreviations: The following abbreviations are applicable to the Pipe and Fitting Schedule:

BS	Black steel.
CI	Cast iron.
FRP	Fibrous glass reinforced plastic piping.
GE	Grooved end.
GGE	Galvanized grooved end.
GMI	Galvanized malleable iron.
GS	Galvanized steel.
HDPE	High density polyethylene pipe.
MI	Malleable iron.
PE	Polyethylene pipe.
SE	Screwed end.
ST	Steel.
SW	Standard weight.
WE	Weld end.
XH	Extra heavy weight.

- B. Where options are given, choose only one option for each piping service. No deviations from selected option will be allowed.
- C. Schedule of Pipe and Fittings for the different piping services is as follows:

1. Bearing Coolant (BWS & BWR) 125 psig & less: Type L hard drawn copper tubing, with wrot copper or cast copper alloy solder fittings, and Type 3 solder.
2. Boiler Blow Off (BO & CBD) 250 psig & less: XH BS pipe with WE XH steel fittings.
3. Boiler Feed Pump Suction (BFS) 125 psig & less:
 - a. 1-1/2 inch and less: SW BS pipe, with SE SW CI fittings, or WE SW ST fittings.
 - b. 2 inch and up: SW BS pipe with WE SW ST fittings.
4. Boiler Feed Pump Discharge (BFD) 126 to 250 psig:
 - a. 1-1/2 inch and less: XH BS pipe, with SE 300 lb MI fittings, or WE XH ST fittings.
 - b. 2 inch and up: XH BS pipe with WE XH ST fittings.
5. Boiler Trim 250 psig and less:
 - a. 1-1/2 inch and less: XH BS pipe, with SE XH CI fittings, or WE XH ST fittings.
 - b. 2 inch and up: XH BS pipe with WE XH ST fittings.
6. Chemical Feed (CMF) 125 psig & less:
 - a. 1-1/2 inch and less: SW BS pipe, with SE SW CI fittings, or WE SW ST fittings.
 - b. 2 inch and Up: SW BS pipe with WE SW ST fittings.
7. Chemical Feed (CMF) 126 to 250 psig:
 - a. 1-1/2 inch and less: XH BS pipe, with SE XH CI fittings, or WE XH ST fittings.
 - b. 2 inch and Up: XH BS pipe with WE XH ST fittings.
8. Chilled Water (CWS & CWR) 125 psig and less:
 - a. 3 inch and less: SW BS pipe with SE SW CI fittings, or Type L hard drawn copper tubing with wrot copper or cast copper alloy solder fittings, and Type 3 solder, or hydraulic press joints.
 - b. 4 inch Size: SW BS pipe, with SE SW CI fittings, or WE SW ST fittings, or GE fittings.
 - c. 5 inch and Up: SW BS pipe, with WE SW ST fittings, or GE fittings.
9. Chilled Water (CWS & CWR) 126 psi to 250 psi:
 - a. 2 inch and less: SW BS pipe with SE SW CI fittings, or Type L hard drawn copper tubing with wrot copper or cast copper alloy solder fittings, and Type 3 solder, or hydraulic press joints.
 - b. Over 2 inch: SW BS pipe, with WE SW ST fittings, or GE fittings.
10. Cold Water (CW) 125 psig and less:
 - a. 3 inch and less: Type L hard drawn copper tubing with wrot copper or cast copper alloy solder fittings, and Type 3 solder, or hydraulic press joints.
 - b. 4 inch and over: _____.
 - c. Exposed Piping Serving Hospital, Laboratory, and Food Service Equipment, Except Piping Installed within Cabinets, and not Exposed to View: Polished, chrome plated grade A brass pipe with chrome plated cast brass fittings, and threaded joints.
11. Compressed Air (A) 175 psig and Less (Above Ground):

- a. Option No. 1: Type L hard drawn copper tubing with cast copper alloy or wrot copper solder fittings, and joints made up with Type 3 solder.
 - b. Option No. 2: SW BS pipe with 150 lb MI fittings.
12. Compressed Air (A) 176 psig thru 300 psig (Above Ground): SW BS pipe with 300 lb. MI fittings.
13. Compressed Air (A) 175 psig and Less (Below Ground):
 - a. Option No. 1: Type K soft annealed copper tubing with refrigerant tube type flared fittings.
 - b. Option No. 2: SW GS pipe with 150 lb GMI fittings.
14. Compressed Air (A) 176 psig thru 300 psig (Below Ground): SW GS pipe with 300 lb GMI fittings.
15. Condensate Returns (LPR, MPR and Pumped Returns) 125 psig and less:
 - a. 1-1/2 inch and less: XH BS pipe, with SE XH CI fittings, or WE XH ST fittings.
 - b. 2 inch and above: XH BS pipe with WE XH ST fittings.
16. Condensate Returns (LPR, MPR and Pumped Returns) 125 psig and less:
 - a. 4 inch and less: XH BS pipe, with SE XH CI fittings, or WE XH ST fittings.
 - b. 5 inch and Up: XH BS pipe with WE XH ST fittings.
17. Condenser Water (CF & CR) 125 psig and less:
 - a. 3 inch and Less: SW BS pipe with SE SW CI fittings, or Type L hard drawn copper tubing with wrot copper or cast copper alloy solder fittings and Type 3 solder, or hydraulic press joints; or fiberglass reinforced plastic piping (FRP) and filament wound or compression molded epoxy fittings.
 - b. 4 inch Size: SW BS pipe, with SE SW CI fittings, or WE SW ST fittings, or GE fittings; or fiberglass reinforced plastic piping (FRP) and filament wound or compression molded epoxy fittings.
18. Condenser Water (CF & CR) 126 to 250 psig: SW BS pipe, with WE SW ST fittings, or GE fittings.
19. Continuous Blow Down (BO & CBD) 250 psig and Less: XH BS pipe with WE XH ST fittings.
20. Domestic Hot Water and Circulating (DHW & DHWC) 125 psig and less:
 - a. 3 inch and less: Type L hard drawn copper tubing, with wrot copper or cast copper alloy solder fittings, and Type 3 solder, or hydraulic press joints.
 - b. 4 inch and up: SW GS pipe with GGE fittings.
 - c. Exposed Piping Serving Hospital, Laboratory, and Food Service Equipment, Except Piping Installed within Cabinets, and not Exposed to View: Polished, chrome plated grade A brass pipe with chrome plated cast brass fittings, and threaded joints.
21. Piping for No. 2 Fuel Oil and Diesel Fuel for Diesel-Alternators:
 - a. Vent Piping:
 - 1) Underground: Single wall FRP with fittings, joining methods, and materials as recommended by the piping system manufacturer.
 - 2) In Containment Sump, and Above Ground: SW BS pipe, with SE 150 lb MI fittings, and fuel resistant thread sealant.

- b. Fuel Oil Product Piping (FOS and FOR):
 - 1) Underground:
 - a) Option No. 1: Type K soft annealed copper tubing with brass or bronze automotive tube type flared fittings, and polyethylene containment pipe.
 - b) Option No. 2: Double wall flexible primary piping with polyethylene containment pipe, with fittings, joining methods, and materials as recommended by flexible primary piping and polyethylene containment pipe manufacturers.
 - c) Option No. 3: Double wall FRP with fittings, joining methods, and materials as recommended by pipe manufacturer.
 - 2) Above Ground
 - a) Option No. 1: SW BS pipe, with SE 150 lb. MI fittings, and fuel resistant thread sealant.
 - b) Option No. 2: Type L hard drawn copper tubing with wrought copper or cast copper alloy fittings, and brazing alloy.
 - c) Option No. 3: Flexible double wall above ground pipe with compression fittings.
 - 3) Inside Building (125 psig and less):
 - a) 3/4 Inch and Less: Type K soft annealed copper tubing with automotive tube type flared fittings.
 - b) 1 Inch and Up: SW BS pipe, with SE 150 lb MI fittings and fuel resistant thread sealant, or WE SW ST fittings.
 - 4) Inside Building (126 to 300 psig):
 - a) 1-1/2 inch and Less: XH BS pipe, with SE 300 lb. MI fittings and fuel resistant thread sealant, or WE XH ST fittings.
 - b) 2 inch and Up: XH BS pipe with WE XH ST fittings.
 - 5) Inside Containment Sump:
 - a) Option No. 1: Type K soft annealed copper tubing with automotive tube type flared fittings.
 - b) Option No. 2: Double wall flexible primary piping with fittings, joining methods, and materials as recommended by flexible primary piping manufacturer.
- c. Protection Piping (when directed):
 - 1) Above Ground: SW GS pipe with SE 150 lb. MI fittings, and fuel resistant thread sealant.
- d. Fill Piping (Underground): SW BS pipe with SE 150 lb MI fittings, and fuel resistant sealant. Coat piping with corrosion protective tape primer, and wrap with corrosion protective tape.
- e. Interstitial Leak Monitor and Probe Riser Piping: SW BS pipe with SE 150 lb MI fittings, and fuel resistant sealant. Coat piping with corrosion protective tape primer, and wrap with corrosion protective tape.

- f. Fuel Oil Suction Drop Pipe: SW BS pipe, length as required to reach within 4 inches of tank bottom.
- 22. High Temperature Water Supply & Return (HTS & HTR) 250 psig and Less: SW BS pipe with WE SW ST fittings.
- 23. Hot Water Supply and Return (HWS & HWR) 125 psig and less:
 - a. 3 inch and less: SW BS pipe with SE SW CI fittings, or Type L hard drawn copper tubing with wrot copper or cast copper alloy solder fittings and Type 3 solder, or hydraulic press joints.
 - b. 4 inch Size: SW BS pipe, with SE SW CI fittings, or WE SW ST fittings, or GE fittings.
 - c. 5 inch and up: SW BS pipe, with WE SW ST fittings, or GE fittings.
- 24. Hot Water (HWS & HWR) 126 psi to 250 psi:
 - a. 2 inch and Less: SW BS pipe, with SE SW CI fittings, or Type L hard drawn copper tubing with wrot copper or cast copper alloy solder fittings, and Type 3 solder, or hydraulic press joints.
 - b. Over 2 inch: SW BS pipe, with WE SW ST fittings, or GE fittings.
- 25. Instrument (Control) Air (IA) 175 psig and Less: Type L hard drawn copper tubing, with refrigerant tube type flared fittings; or wrot copper or cast copper alloy solder fittings, and Type 3 solder.
- 26. Liquefied Petroleum, LP (G):
 - a. Outside Buildings: Type K soft annealed copper tubing, with refrigerant tube type flared fittings.
 - b. Inside Buildings: SW BS pipe with SE 150 lb MI fittings, or WE SW ST fittings.
 - c. Exposed Piping Serving Hospital, Laboratory, and Food Service Equipment, Except Piping Installed in Cabinets, and not Exposed to View: Polished, chrome plated Grade A brass pipe with chrome plated cast brass fittings, and threaded joints.
- 27. Liquefied Petroleum, LP (G): HDPE piping with butt or socket fusion fittings, unless otherwise required by serving gas supplier.
- 28. Natural Gas (G) including associated vent, 125 psig and less:
 - a. 1-1/2 inch and Less: SW BS pipe, with SE 150 lb. MI fittings, or WE SW ST fittings.
 - b. 2 inch and up: SW BS pipe with WE SW ST fittings.
 - c. Exposed Piping Serving Hospital, Laboratory, and Food Service Equipment, Except Piping Installed in Cabinets, and not Exposed to View: Polished, chrome plated grade A brass pipe with chrome plated cast brass fittings, and threaded joints.
- 29. Natural Gas (G) Underground: HDPE piping with butt or socket fusion fittings, unless otherwise required by serving gas supplier.
- 30. Refrigerants (RS, RL, HG & RD) 350 psig and less:
 - a. All Sizes: Type ACR hard drawn copper tubing with wrot copper fittings, and brazing alloy, unless otherwise specified.
 - b. 3/4 inch o.d. size and Less (for final connection within 24 inches of refrigerant equipment): Soft annealed Type ACR copper tubing with refrigerant tube type flared fittings.
- 31. Secondary Water (SWS & SWR) 125 psig and less:

- a. 3 inch and less: SW BS pipe with SE SW CI fittings, or Type L hard drawn copper tubing with wrot copper or cast copper alloy solder fittings and Type 3 solder, or hydraulic press joints.
 - b. 4 inch and up: SW BS pipe, with SE SW CI fittings, or WE SW ST fittings, or GE fittings.
32. Steam (LPS & MPS) 125 psig and less:
- a. 4 inch and Less: SW BS pipe, with SE SW CI fittings, or WE SW ST fittings.
 - b. 5 inch and Up: SW BS pipe with WE SW ST fittings.
 - c. Exposed Piping Serving Hospital, Laboratory, and Food Service Equipment, Except Piping Installed within Cabinets, and not Exposed to View: Polished, chrome plated grade A brass pipe with chrome plated cast brass fittings, and threaded joints.
33. Steam (HPS) 126 to 250 psig:
- a. 1-1/2 inch and less: SW BS pipe, with SE XH CI fittings, or WE & SW ST fittings.
 - b. 2 inch and up: SW BS pipe with WE SW ST fittings.
34. Vents (V):
- a. 4 inch and less: SW BS pipe, with SE SW CI fittings, or GE fittings.
 - b. 5 inch and up: SW BS pipe, with WE SW ST fittings, or GE fittings.
35. Drain Piping:
- a. Condensate Drain Piping: Type M hard drawn copper tubing with wrot copper or cast copper alloy solder fittings, and Type 3 solder.
 - b. Overflow Drain Piping (Deaerator, Return Tank, and Condensate Return Unit): XH BS pipe with WE XH ST fittings.
 - c. Drain Piping other than Condensate and Overflow Drains: SW BS pipe, with SE SW CI fittings, or WE SW ST fittings.

END OF SECTION

SECTION 232003

THERMOMETERS AND GAUGES

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Valves: Section 230523.
- B. Pumps: Section 232123.

1.02 SUBMITTALS

- A. Product Data: Manufacturer's catalog sheets, specifications and installation instructions for each item specified.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Where Federal, NSF, ASME or other standards are indicated or required, products shall meet or exceed the standards established for material, quality, manufacture and performance.

PART 2 PRODUCTS

2.01 MANUFACTURERS/COMPANIES

- A. Dresser Instruments.
- B. Marsh Bellofram.
- C. Moeller Instrument Co.
- D. Taylor Precision Products.
- E. H.O. Trerice Co.
- F. Weksler Instruments Corp.

2.02 THERMOMETERS

- A. General Design Features:
 - 1. Scale Ranges: 1-1/2 times actual working temperature required for the particular application, as approved.
 - a. Maximum of two degrees between graduations and ten degrees between numerals.
 - b. When scale ranges are in excess of 100 degrees, maximum range between numerals may be 20 degrees, or as otherwise approved for the particular application.

2. Direct Reading Thermometers: Bimetallic actuated, dial type, straight pattern, angle pattern, or adjustable angle pattern as required.
3. Remote Reading Thermometers: Vapor tension actuated, or gas actuated type, with extension capillary tube of length as required for the particular application.
 - a. Case type as required for the particular mounting application.
4. Thermometers for Sensing Liquid Temperature: Furnish with separable sockets.
 - a. Sockets for Use in Insulated Piping, Insulated Tanks or Similar Equipment: Extension lagging neck type, of length as required to compensate for insulation thickness, and proper immersion..

2.03 THERMOMETERS FOR MEASURING LIQUID TEMPERATURE

- A. Bimetallic Actuated Thermometers: Comply with ASME B40.3, Accuracy Grade A.
 1. Construction: Type 304 stainless steel, all welded construction, with clear acrylic plastic or shatterproof glass crystal.
 2. Dial: White enamel background with bold black figures and graduations.
 3. Head Size:
 - a. Installation in Piping: 3inch diameter.
 - b. Installation in Tanks and Similar Equipment: 5 inch diameter.
 3. Stem: Length as required for proper immersion, and to compensate for insulation thickness, with threaded connection for socket.
 4. External Calibration Device.
 5. Separable Socket:
 - a. Water Service: Brass or bronze.
 - b. Steam Service: Stainless steel.
- B. Vapor Tension or Gas Actuated Capillary Thermometers: Adjustable type, with micrometer type pointer or external calibration device, of design and materials as follows:
 1. Case and Ring: Stainless steel or non-ferrous material as approved, with clear acrylic or shatterproof glass lens. Provide case of type as required for the particular mounting application. Case adjustable, allowing rotation of 360°, and stem adjustment of at least 180°. Provide set screw for locking case in desired position.
 2. Movement: Brass with bronze bearings.
 3. Dial: White enamel background, with bold black graduations, numerals and pointer; 3-1/2 inch diameter.
 4. Capillary: Stainless steel.
 5. Bulb: Copper with union well connection.
 6. Separable Socket:
 - a. Water Service: Brass or bronze.
 - b. Steam Service: Stainless steel.

2.04 THERMOMETERS FOR MEASURING AIR TEMPERATURE

- A. Bimetallic Actuated Thermometers: Comply with ASME B40.3, Accuracy Grade A.
 1. Construction: Type 304 stainless steel, all welded construction, with clear acrylic plastic or shatterproof glass crystal.
 2. Dial: White enamel background with bold black figures and graduations.
 3. Head Size: 5 inch diameter.
 4. Stem: Length as required for average duct cross sectional sensing of air temperature, and to compensate for insulation thickness.

5. External calibration device.
- B. Vapor Tension or Gas Actuated Capillary Thermometers: Adjustable 3-1/2 inch dial type, with micrometer type pointer or external calibration device, of design and materials as follows:
 1. Case and Ring: Stainless steel or non-ferrous material as approved, with clear acrylic or shatterproof glass lens. Case adjustable allowing rotation of 360°, and stem adjustment of at least 180°. Provide set screw for locking case in desired position.
 2. Movement: Brass with bronze bearings.
 3. Dial: White enamel background, with bold black graduations, numerals and pointer; 3-1/2 inch diameter.
 4. Capillary: Stainless steel.
 5. Bulb: Copper air sensing bulb with split flange mounting device.

2.05 PRESSURE AND COMPOUND GAUGES

- A. Type: Adjustable dial type with micrometer type pointer, or external calibration device, bronze bourdon tube, and bronze bushed rotary movement.
- B. Dial: White enameled background, and bold black graduations, numerals and pointer; 3-1/2 inch diameter.
 1. Scale Range:
 - a. Standard Gauges: Double normal operating pressure.
 - b. Compound Gauges: From 30" Hg vacuum to double normal operating pressure.
- C. Case: Cast aluminum, brass, or black finished phenolic.
- D. Accuracy: Guaranteed of within 1 percent in middle third of dial range.

2.06 PRESSURE SNUBBERS AND IMPULSE DAMPERS

- A. Pressure Snubbers: H.O. Trerice Co. Model 872.
- B. Impulse Dampers: H.O. Trerice Co. Model 870.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Thermometers:
 1. Install in accordance with the manufacturer's printed installation instructions.
 2. Install direct reading thermometers, when the application requires installation 6 feet or less above the floor or bottom of space in which installed, and remote reading type when the installation is over 6 feet.
 3. Install air temperature reading thermometers for measuring duct, plenum and other air temperature applications of type as specified under sections entitled "Direct Digital Building Control Systems", "Temperature Control Systems", or "Combustion Controls and Instrumentation" in this Project Manual.

- B. Pressure and Vacuum Gauges:
 - 1. Install in accordance with the manufacturer's printed installation instructions.
 - 2. For Measuring Steam Pressure: Install gauges complete with needle valves, drain cocks and syphons.
 - 3. For Measuring Liquid Pressure: Install gauges complete with stop cocks and drain cocks.
- C. Pressure Snubbers and Impulse Dampers:
 - 1. Install pressure snubbers in the piping connections to gauges installed in suction and discharge piping connections to close coupled and base mounted circulating pumps driven by motors under 10 HP.
 - 2. Install impulse dampers in the piping connections to gauges installed in suction and discharge piping connections to close coupled and base mounted circulating pumps driven by motors 10 HP and over.

END OF SECTION

SECTION 233113

METAL DUCTWORK

PART 1 GENERAL

1.01 REFERENCES

- A. American Conference of Governmental Industrial Hygienists (ACGIH).
- B. National Fire Protection Association (NFPA).
- C. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

1.02 PERFORMANCE REQUIREMENTS

- A. Design ductwork and supports to withstand all seismic loads. Refer to seismic loading criteria on the Contract Drawings.
- B. Seismic Performance: Design and install ductwork to assure continued performance of their intended function when subjected to the specified seismic forces.
- C. Seismic Performance: Design and install ductwork to assure that they remain in place with no separation of any parts when subjected to the specified seismic forces.
- D. The design of the ductwork and supports shall be performed by a professional engineer experienced in the seismic design of ductwork.

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Layouts for areas in which it may be necessary to deviate substantially from layout shown on the Drawings. Show major relocation of ductwork and major changes in size of ducts. Minor transitions in ductwork, if required due to job conditions, need not be submitted as long as the duct area is maintained.
 - 2. Layout and fabrication details for cooking equipment exhaust ductwork.
 - 3. Layouts of mechanical equipment rooms and penthouses.
 - 4. Details of intermediate structural steel members required to span main structural steel for the support of ductwork.
 - 5. Method of attachment of duct hangers to building construction.
 - 6. Coordinate shop drawings with related contracts prior to submission.
 - 7. Drawings identifying seismic locations with corresponding details of pre-approved seismic restraints, with seismic loads and seismic force level (Fp) calculations; pre-engineered and stamped by a NYS Licensed Professional Engineer experienced in seismic restraint systems.

- B. Product Data: Material, gage, type of joints, sealing materials, and reinforcing for each duct size range, including sketches or SMACNA plate numbers for joints, method of fabrication and reinforcing. Include ACGIH figure numbers for hoods if applicable.
- C. Quality Control Submittals:
 - 1. Seismic Restraint Manufacturer's Qualifications Data:
 - a. Name of firm producing the seismic restraints, business address and telephone number.
 - b. Period of time firm has been in the business producing seismic restraints, and names and addresses of 3 similar projects that the manufacturer has produced seismic restraints for during the past 5 years.
 - 2. Company Field Advisor Data:
 - a. Name, business address and telephone number of Company Field Advisor secured for the required services.
 - b. Certified statement from the Company listing the qualifications of the Company Field Advisor.
 - c. Services and each product for which authorization is given by the Company, listed specifically for this project.
 - 3. Manufacturer's Certificate of Compliance for Seismic Restraints: Certificate from seismic restraint manufacturer stating that the restraint and its mounting system or anchorage has been tested or analyzed and meets the requirements of NYS Building Code (Section 1621).

1.04 QUALITY ASSURANCE

- A. SMACNA: Gages of materials, fabrication, reinforcement, sealing requirements, installation, and method of supporting ductwork shall be in accordance with the following SMACNA manuals, unless otherwise shown or specified:
 - 1. HVAC Duct Construction Standards.
 - 2. Round Industrial Duct Construction Standard.
 - 3. Rectangular Industrial Duct Construction Standard.
 - 4. Seismic Restraint Manual Guidelines for Mechanical Systems.
- B. Unless otherwise shown or specified, follow the Hood Design Data, and Construction Guidelines for Local Exhaust Systems from the ACGIH Industrial Ventilation Manual.
- C. Conform to the applicable requirements of NFPA 90A, 90B, 91, 96, and 101.
- D. Regulatory Requirements:
 - 1. Seismic components shall be UL listed or California OSHPD (Office of Statewide Health Planning and Development) approved.
 - 2. Seismic restraints for ductwork shall conform with Appendix B of the SMACNA Seismic Restraint Manual Guidelines for Mechanical systems.
- E. Seismic Restraint Manufacturer's Qualifications: The firm producing the seismic restraints shall be experienced in seismic restraint work and shall have produced seismic restraints on minimum of 3 similar projects over the past 5 years.

- F. Company Field Advisor: Secure the services of a Company Field Advisor from seismic restraint manufacturer for the following:
 - 1. Render advice regarding installation and final adjustment of seismic restraint system.
 - 2. Render advice on the suitability of each seismic restraint for its particular application.
 - 3. Inspect completed installation of seismic restraint system and certify with an affidavit that the system is installed in accordance with the Contract Documents and is operating properly.
 - 4. Train facility maintenance personnel on the installation of seismic restraint system and routine maintenance of the system.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sheet Metal:
 - 1. Aluminum: ASTM B-209, Alloy 3003, Temper H-14.
 - 2. Copper: ASTM B-370.
 - 3. Galvanized Steel: ASTM A653, Class LFQ (lock forming quality), coating designation G-90.
 - 4. Monel: ASTM B-127.
 - 5. Stainless Steel: AISI Types 302, 304 and 316, as specified.
- B. Duct Hangers:
 - 1. Strap Hangers: Same material as ducts, except that hangers for stainless steel ducts in unfinished spaces may be galvanized steel.
 - 2. Rod Type Hangers: Mild low carbon steel, unless otherwise specified; fully threaded or threaded each end, with 2 removable nuts each end for positioning and locking rod in place. Unless stainless steel, galvanized or cadmium plated; shop coat with metal primer.
- C. Miscellaneous Fasteners and Upper Hanger Attachments:
 - 1. Sheet Metal Screws, Machine Bolts and Nuts: Same material as duct, unless otherwise specified.
 - 2. Concrete Inserts: Steel or malleable iron, galvanized; continuously slotted or individual inserts conforming with MSS SP-58, Types 18 & 19, Class A-B.
 - 3. C Clamps: Fee & Mason Co.'s 255L with locking nut, and 255S with retaining strap.
 - 4. Metal Deck Ceiling Bolts: B-Line Systems, Inc.'s Fig. B3019.
 - 5. Welding Studs: Erico Fastening Systems, capacitor discharge, low carbon steel, copper flashed.
 - 6. Structural (carbon) Steel Shapes and Steel Plates: ASTM A36, shop primed.
 - 7. Stainless Steel Shapes and Plates: ASTM A276 and ASTM A666.
 - 8. Machine Bolt Expansion Anchors:
 - a. Non-caulking single unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 1.

- b. Non-caulking double unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 2.
- c. Self-drilling type: FS FF-S-325, Group III, Types 1 and 2.

2.02 FABRICATION - GENERAL

- A. Fabricate ductwork from galvanized sheet metal, except as follows:
 - 1. Fabricate the following ductwork from aluminum:
 - a. Inlet and discharge ductwork connected to cooling towers and evaporative condensers.
 - b. Exhaust ductwork from shower, locker, can washing and steam service rooms, and swimming pool areas.
 - 2. Fabricate the following ductwork from stainless steel:
 - a. Supply, return, and recirculated air ductwork connected to inlet or outlet devices installed in surgical operating, surgical scrub-up, surgical recovery and surgical work rooms. Use AISI Type 302 or 304 stainless steel.
 - b. Exhaust ductwork connected to cooking equipment, dishwashing, and other scullery equipment hoods. Install stainless steel from the individual hood to its respective fan and from the fan to the point of discharge to the outside air. Use AISI Type 302 or 304 stainless steel.
 - c. Exhaust ductwork connected to laboratory exhaust fume hoods. Install stainless steel from the individual hood to its respective fan and from the fan to the point of discharge to the outside air. Use AISI Type 316 stainless steel.
 - d. Use stainless steel with a No. 4 finish where installed exposed in finished rooms and No. 2B finish in other locations. Use stainless steel fasteners for ductwork installed exposed in finished rooms and where fastener penetrates duct. Galvanized fasteners may be used in unfinished spaces for non-penetrating service.
- B. Dissimilar Metals: Separate dissimilar metals used for ductwork with 12 oz vinyl coated woven fiberglass duct connector fabric, such as Duro Dyne's Glassteel. No separation is required between screws or rivets and the materials in which they are inserted.

2.03 FABRICATION OF STAINLESS STEEL DUCTS

- A. Use minimum No. 18 gage for exhaust ducts connected to cooking equipment hoods. Use minimum No. 20 gage for exhaust ducts connected to other hoods.
- B. Use stainless steel reinforcing members for ducts in finished spaces and galvanized steel in unfinished spaces.
- C. Longitudinal Seams For Dishwashing, and Other Scullery Equipment Exhaust Ducts: Form double corner seams, or Pittsburgh lock seams.
 - 1. Fabricate elbows and transitions with Pittsburgh lock seams.
 - 2. Fabricate double compounded elbows and other complex fittings with double corner seams.

3. Locate seams in horizontal ducts at top corners of ducts, unless otherwise approved in writing.
4. Locate seams in vertical ducts at rear corners of ducts.

2.04 REGISTERS AND GRILLES INSTALLED IN EXPOSED DUCTWORK

- A. Frames are not required for registers and grilles installed directly in uninsulated exposed ductwork.
- B. Cut openings in ducts, forming a double thickness of metal, to attach registers or grilles with sheet metal screws. Bend back edges of openings into duct, on all 4 sides, a minimum of 1 inch to provide the thickness of metal stated above. Provide felt or sponge rubber gasketing, all 4 sides of duct openings, for supply grilles and supply registers.

2.05 AIR DIFFUSERS INSTALLED IN EXPOSED DUCTWORK

- A. Frames are not required for diffusers installed directly in uninsulated exposed ductwork.
- B. Cut and form openings in ducts, to accommodate the specified volume control damper and adjustable equalizing grid assembly. Reinforce openings as required and approved. Provide felt or sponge rubber gasketing, around duct opening, for supply diffuser assemblies.

2.06 VIBRATION ISOLATION FOR DUCTWORK

- A. Type: Combination rubber and spring type designed for insertion in a split hanger rod for isolating ductwork from the overhead construction.
 1. Approved isolators: Amber Booth Type BSSR, Korfund Type VX, Mason Industries, Type DNHS, Vibration Eliminator Co. Type SNRC and Vibration Mountings and Controls Type RSH.

2.07 SEISMIC RESTRAINT SYSTEM FOR DUCTWORK

- A. General:
 1. Coordinate all structural attachments with the Director's Representative.
 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 and as specified.
 5. Construct seismic supports so that support engagement is maintained.
 6. Stamp seismic supports with manufacturer's name and part number for identification.
 7. Design seismic supports specifically for mitigation of seismic force loads.
 8. Design the stiffness of seismic restraints for mechanical equipment so that the load path for the restraint performs its intended function.

9. Where possible, utilize components designed with tamper resistant break-off bolt heads or break-off nuts to assure visual verification of proper installation.
 10. 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 ductwork to meet applicable lateral force requirements.
- C. Acceptable Manufacturers:
1. B-Line.
 2. Mason Industries.
 3. TOLCO Inc.
- D. Strut/Channel Bracing: 12 gauge solid 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 steel pipe.
- F. Cable Bracing: Pre-stretched galvanized aircraft cable 7 x 19 strand core.
- G. Rigid Seismic Braces For Single Hung Duct Systems: A12 strut channel or schedule 40 steel pipe
1. Maximum Brace Length: 13 feet 1 inches.
- H. Rigid Seismic Braces For Trapeze Supported Duct Systems: A12 strut channel or schedule 40 steel pipe
1. Maximum Brace Length: 13 feet 1 inches.
- I. Cable Seismic Braces For Single Hung Duct Systems: Pre-stretched aircraft cable 7 x 19 core.
- J. Cable Seismic Braces For Trapeze Supported Duct Systems: Pre-stretched aircraft cable 7 x 19 core.
- K. Structural Attachments for Rigid and Cable Seismic Braces for Single Hung and Trapeze Supported Duct 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 will be determined by the manufacturer, 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.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Install ductwork to allow maximum headroom. Properly seam, brace, stiffen, support and render ducts mechanically airtight. Adjust ducts to suit job conditions. Dimensions may be changed as approved, if cross sectional area is maintained.
- B. Pitch horizontal ducts connected to hoods downward toward hood not less than 1 inch in 10 feet.
- C. Provide necessary transformation pieces, and flexible fabric connections for ductwork connected to air handling equipment or air inlet and outlet devices.

3.02 SEALING SEAMS, JOINTS, AND PENETRATIONS

- A. Seal ductwork in accordance with the SMACNA Manual except for the following:
 - 1. Ductwork Specified to be Insulated: Conform with Seal Class A for all pressure classes.
 - 2. Cooking Equipment Exhaust Ductwork: Conform with NFPA 96.
 - 3. Horizontal Ductwork for Dishwashing, and Other Scullery Equipment Exhausts:
 - a. Continuously solder transverse joints vaportite along bottom, and up both sides 2 inches minimum.
 - b. Continuously solder longitudinal seams vaportite if seams are approved to be located at bottom of duct.
- B. Duct Sealants: Water based, non-fibrated: Foster 32-19, Childers CP-146, Duro Dyne SAS.

3.03 HANGERS FOR DUCTS, UNDER 2 INCHES W.G.

- A. Install hangers for ducts as specified in the SMACNA Manual, with the following exceptions:
 - 1. Rectangular ducts up to 42 inches wide, not having welded or soldered seams, and supported from overhead construction; extend strap hangers down over each side of the duct and turn under bottom of duct a minimum of 2 inches. Secure hanger to duct with 3 full thread sheet metal screws, one in the bottom and 2 in the side of the duct.
 - 2. Rectangular ducts 43 inches wide and over, and all sizes of duct with welded or soldered seams, and supported from overhead construction; use trapeze hangers.
 - 3. Prime coat plain steel rods threaded at the site immediately after installation with metal primer.

3.04 HANGERS FOR DUCTS, 2 INCHES W.G. AND OVER

- A. Install hangers for ducts as specified in the SMACNA Manual, with the following exceptions:
 - 1. Support rectangular ducts, regardless of size, by means of trapeze hangers, framed all four sides. Provide minimum 1 x 1 x 1/8 inch angle iron framing for duct having a maximum side dimension up to and including 36 inches in size. Install framing snug to all four sides of duct.

3.05 UPPER HANGER ATTACHMENTS

- A. General:
 - 1. Secure upper hanger attachments to structural steel or steel bar joists wherever possible.
 - 2. Do not use drive-on beam clamps, flat bars or bent rods, as upper hanger attachments.
 - 3. Do not attach hangers to steel decks which are not to receive concrete fill.
 - 4. Do not attach hangers to precast concrete planks less than 2-3/4 inches thick.
 - 5. Avoid damage to reinforcing members in concrete construction.
 - 6. Metallic fasteners installed with electrically operated or powder driven tools may be used as upper hanger attachments, in accordance with the SMACNA Manual, with the following exceptions:
 - a. Do not use powder driven drive pins or expansion nails.
 - b. Do not attach powder driven or welded studs to structural steel less than 3/16 inch thick.
 - c. Do not support a load, in excess of 250 lbs from any single welded or powder driven stud.
 - d. Do not use powder driven fasteners in precast concrete.
- B. Attachment to Steel Frame Construction: Provide intermediate structural steel members where required by ductwork support spacing. Select steel members for use as intermediate supports based on a minimum safety factor of 5.
 - 1. Secure upper hanger attachments to steel bar joists at panel points of joists.
 - 2. Do not drill holes in main structural steel members.
- C. Attachment to Concrete Filled Steel Decks:
 - 1. New Construction: Install metal deck ceiling bolts.
 - 2. Existing Construction: Install welding studs (except at roof decks).
 - 3. Do not attach hangers to decks less than 2-1/2 inches thick.
- D. Attachment to Existing Cast-In Place Concrete:
 - 1. Secure hangers to overhead construction with self drilling type expansion anchors and machine bolts.
 - 2. Secure hanger attachments required to be supported from wall or floor construction with single unit expansion anchors or self drilling type expansion anchors and machine bolts.

- E. Attachment to Cored Precast Concrete Decks (Flexicore, Dox Plank, Spancrete, etc.): Toggle bolts may be installed in cells for the support of ducts up to a maximum of 60 inches in width.
- F. Attachment to Hollow Block or Hollow Tile Filled Concrete Decks:
 - 1. New Construction: Omit block or tile and pour solid concrete with cast-in-place inserts.
 - 2. Existing Construction: Break out block or tile to access, and install machine bolt anchors at highest practical point on side of web.
- G. Attachment to Waffle Type Concrete Decks:
 - 1. New Construction: Install cast-in-place inserts.
 - 2. Existing Construction: Install machine bolt expansion anchors at highest practical point on side of web.
- H. Attachments to Precast Concrete Tee Construction:
 - 1. Secure hangers to tees by any of the following methods:
 - a. Tee hanger inserts between adjacent flanges.
 - b. Install double unit expansion anchors and machine bolts at highest practical point on side of web.
- I. Attachment to Wood Construction:
 - 1. Secure strap hangers to the sides of wood beams with one No. 18 x 1-1/2 inch long (minimum) wood screws or 2 No. 16 x 1-1/2 inch long (minimum) drive screws. Do not hammer in wood screws.
 - 2. Secure rod hangers to angle iron clip angles, bolted or screwed to the sides of the wood beams with 3/8 inch bolts or 3/8 inch lag screws. Install hanger rods with a threaded end through a hole in the angle, secured with a double nut, one above and one below the angle. Do not use lag screws in wood beams, having a nominal face width under 2 inches. Install bolts or lag screws in the side of beams at mid-point or above.
 - 3. Pre-drill holes for lag screws 1/8 inch in diameter less than the root diameter of the lag screw thread.
 - 4. Where wood trusses are approved to support ductwork, hangers may be attached only to the bottom chord. Method of attachment must be specifically approved.
 - 5. Do not secure hanger attachments to nailing strips resting on top of steel beams.

3.06 DUCT RISER SUPPORTS, UNDER 2 INCHES W.G.

- A. Support vertical round ducts by means of double-ended split steel pipe riser clamps bearing on floor slabs or adjacent structural members, at every other floor through which the riser passes.
- B. Unless otherwise specified or shown on the drawings, support vertical rectangular ducts by means of two steel angles, secured to duct and resting on floor slab or adjacent structural steel member, at every other floor through which the duct passes. Size supports as follows:

MAX. SIDE DIMENSION (inches)	SUPPORT ANGLE (inches)	SECURE TO DUCT WITH	MIN BEARING AT EACH END (inches)
36	1 x 1 x 1/8	Screws	2
48	1-1/2 x 1-1/2 x 1/8	Bolts	3
60	2 x 2 x 1/8	Bolts	3
61 - up	2-1/2 x 2-1/2 x 3/16	Bolts	4

3.07 DUCT RISER SUPPORTS, 2 INCHES W.G. AND OVER

- A. Support vertical round ducts by means of double-ended split steel pipe riser clamps welded to the ducts and bearing on floor slabs or adjacent structural members, at every other floor through which the riser passes.
- B. Support vertical rectangular ducts by means of two steel angles or channels, anchor bolted to floor slab or adjacent structural member at every other floor through which the riser passes. Secure steel angles or channels to a transverse joint by means of 3/8 inch bolts, or by welding. Size supports as follows:

MAXIMUM SIDE DIMENSION (inches)	SUPPORT ANGLE (inches)	SUPPORT CHANNEL (inches)	MINIMUM BEARING AT EACH END (inches)
36	1 x 1 x 1/8	1 x 1/2 x 1/8	2
48	1-1/2 x 1-1/2 x 1/8	1-1/2 x 3/4 x 1/8	3
60	2 x 2 x 1/8	2 x 1 x 1/8	3
61 - up	2-1/2 x 2-1/2 x 3/16	2 x 1 x 3/16	4

3.08 VIBRATION ISOLATION FOR DUCTWORK

- A. Install vibration isolation in accordance with the manufacturer's printed installation instructions, unless otherwise specified.
- B. High Velocity Ductwork Installed within Mechanical Equipment, Machine and Penthouse Mechanical Equipment Rooms: Provide combination rubber and spring type isolators, designed for insertion in a split hanger rod for overhead supported ductwork and double rubber-in-shear isolators for floor supported ductwork. Provide isolators designed for a static deflection of 1/2 inch.

3.09 SEISMIC RESTRAINT SYSTEM FOR DUCTWORK

- A. General:
 1. Do not use powder-actuated fasteners for seismic restraint anchorage in tension applications.
 2. Install seismic restraints in accordance with seismic restraint manufacturer's printed installation instructions and guidelines unless otherwise specified.

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 duct, equipment or support connections.
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 loads to the Director's Representative for approval.
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. Notify Director's Representative if any discrepancies between the specifications and field conditions prior to installation.

B. Seismic Restraints for Ductwork:

1. Provide seismic restraint of ductwork systems in accordance with the latest edition of the seismic Restraint Manual.
2. Provide seismic restraint on all ductwork systems:
3. Ductwork not requiring Seismic restraints include the following:
 - a. Ducts suspended by individual hangers 12 inches or less in length from the top of the duct to supporting structure, providing the hangers are detailed to avoid significant bending of the hangers and their connections.
 - b. Ducts having a cross-sectional area of less than 6 square feet.
4. Provide longitudinal and transverse seismic restraints in accordance with the Contract Drawings, with members sized in accordance with tables for seismic Level __, as defined in the latest edition of SMACNA Seismic Restraint Manual.
5. Brace trapeze assemblies supporting ducts considering the total weight of the duct on the trapeze.
6. Provide transverse bracing at 30 ft. maximum spacing for duct.
7. Provide longitudinal bracing at 60 ft. maximum spacing for duct.
 - a. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section of the same size 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.
 - b. Brace duct running perpendicular to or over the top of fire suppression and or hazardous piping as required if its failure can cause damage to those systems.
8. Equipment installed in-line with the duct system (ex. Fans, humidifiers, etc) with an operating weight greater than 75 lbs. shall be supported and

laterally braced independently of the duct system and shall meet the force requirements of Section 1621.1.4 of Building Code of New York State.

9. The interaction between mechanical and electrical equipment and the supporting structures shall be designed into the seismic restraint systems.
10. Friction clips shall not be used for anchorage attachments.
11. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction and vertical restraints shall be provided to resist overturning.
12. Brace vibration isolated duct with cables to allow flexibility.

END OF SECTION

SECTION 233300

DUCTWORK ACCESSORIES

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Metal Ductwork: Section 233113.

1.02 REFERENCES

- A. ACGIH: American Conference of Governmental Industrial Hygienists.
- B. AMCA: Air Movement and Control Association.
- C. NFPA: National Fire Protection Association.
- D. SMACNA: Sheet Metal and Air Conditioning Contractors National Association, Inc.
- E. UL: Underwriters Laboratories, Inc.

1.03 SUBMITTALS

- A. Product Data: Catalog sheets, diagrams, standard schematic drawings, and installation instructions for each manufactured product. Submit SMACNA Figure Numbers for each shop fabricated item.
- B. Samples: When directed, submit one complete unit for each type of proposed air inlet and outlet device. Approved samples will be delivered to the job site for installation.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Unless otherwise shown or specified, comply with the applicable requirements of the following:
 - a. SMACNA: Gages of materials, fabrication, sealing, and installation shall be in accordance with the SMACNA Manuals.
 - 1) HVAC Duct Construction Standards.
 - 2) Round Industrial Duct Construction Standard.
 - 3) Rectangular Industrial Duct Construction Standard.
 - b. ACGIH: Follow the Hood Design Data, and Construction Guidelines for Local Exhaust Systems from the Industrial Ventilation Manual.
 - c. AMCA: Certify damper and/or louver ratings in accordance with AMCA 511.
 - d. NFPA: Standards Nos. 90A, 90B, 91, 96, and 101.

- e. UL: Standards No. UL181, UL555, and UL555S.

1.05 MAINTENANCE

- A. Special Tools:
 - 1. One bar deflection key for every five supply grilles and/or every five return grilles.
 - 2. One operator key for every five supply registers and/or every 5 return or exhaust registers.
 - 3. Two keys or socket wrenches for each type of damper adjustment screw or device on manual damper regulators.
 - 4. One tool for each type and size security fastener.

PART 2 PRODUCTS

2.01 GRILLES AND REGISTERS

- A. Unless otherwise specified, fabricate grille and register faces, and frames of steel with factory applied white baked-on enamel.
- B. Fabricate grille, register faces, and frames of aluminum with an etched and acrylic coated finish when installed in shower, can washing, dishwashing, food serving and dining rooms, kitchens and swimming pool areas.
- C. Fabricate grille and register faces, and frames of Type 302 or 304 stainless steel, with a No. 4 finish when installed in surgical operating, surgical scrub-up, surgical recovery and surgical work rooms.
- D. Supply Grilles: Adjustable, double deflection type.
 - 1. Grille Face: 20 gage construction of same material as bars/vanes.
 - 2. Face and Rear Bars/Vanes: Installed in grille face.
 - a. Bars/vanes individually adjustable and front pivoting to any desired setting by means of bar deflection key.
 - b. Nominal Bar/Vane Spacing: 0.66 inch or 0.75 inch on center.
- E. Exhaust or Return Grilles: Fixed, single deflection type.
 - 1. Grille Face: 20 gage construction of same material as bars/vanes.
 - 2. Face Bars/Vanes: Installed in grille face.
 - a. Deflection Angle: 20 to 55 degrees.
 - b. Nominal Bar/Vane Spacing: 0.66 inch or 0.75 inch on center.
 - c. Sidewall grilles shall have horizontal face bars/vanes.
- F. Supply Registers: Adjustable, double deflection type.
 - 1. Register Face: 20 gage construction of same material as bars/vanes.
 - 2. Face and Rear Bars/Vanes: Installed in register face.
 - a. Bars/vanes individually adjustable and front pivoting to any desired setting by means of bar deflection key.
 - b. Nominal Bar/Vane Spacing: 0.66 inch or 0.75 inch on center.

3. Damper Assembly: Opposed multi-blade type consisting of frame, blades, and key operated movement of the locking type.
 - a. Operators: Key operated type projecting through frame or screwdriver slot. Operator keys are removable or may be permanently driven in place, as directed.
 - b. Construction:
 - 1) For use with Aluminum or Stainless Steel Register Faces: Aluminum with etched or acrylic finish.
 - 2) For use with Factory Painted Register Faces: Galvanized steel factory finished with baked on black enamel, unless otherwise approved by the Director's Representative.
- G. Exhaust or Return Registers: Fixed single deflection type.
 1. Register Face: 20 gage construction of same material as bars.
 2. Face Bars/Vanes: Installed in register face.
 - a. Deflection Angle: 20 to 55 degrees.
 - b. Nominal Bar/Vane Spacing: 0.66 inch or 0.75 inch on center.
 - c. Sidewall registers shall have horizontal face bars/vanes.
 3. Damper Assembly: Opposed multi-blade type consisting of frame or screwdriver slot blades, and key operated movement of the locking type.
 - a. Operators: Key operated type projecting through frame or screwdriver slot. Operator keys are removable or may be permanently driven in place, as directed.
 - b. Construction:
 - 1) For use with Aluminum or Stainless Steel Register Faces: Aluminum with etched or acrylic finish.
 - 2) For use with Factory Painted Register Faces: Galvanized steel factory finished with baked on black enamel, unless otherwise approved by the Director's Representative.
- H. Mounting Frames for Registers and Grilles:
 1. Fabricated from a minimum of No. 20 USS gage stamped or rolled steel, or extruded aluminum, to match material and finish of mating grille or register face.
 - a. Weld exposed joints and ground flush.
 - b. Completely close corner joints with neatly welded backtrim.
 - c. Furnish frames complete with felt or sponge rubber gaskets on all four sides, except when frames are used as plaster stops.

2.02 AIR DIFFUSERS

- A. Unless otherwise specified, fabricate diffusers of steel with factory-applied finish as follows:
 1. Prime coat for installation in walls and gypsum board, hard plaster or acoustic plaster ceilings specified to be painted.
 2. Baked-on white enamel for installation in splined acoustic ceilings, metal pan ceilings and suspended lay-in tile ceilings.

- B. Fabricate diffusers of aluminum with an etched and clear acrylic coated finish where installed in shower, can washing, dishwasher, food serving and dining rooms, kitchens, swimming pool areas, surgical operating, surgical scrub-up, surgical recovery and surgical work rooms.
- C. General:
 - 1. Roll or round and reinforce all exposed edges of diffusers.
 - 2. Internal diffuser parts shall be readily removable to permit cleaning and access to ducts.
 - 3. Design removable parts and assemblies so that they cannot be reassembled in a manner that would produce an incorrect air distribution pattern.
 - 4. Secure internal assemblies with fasteners that allow removal without use of special tools.
 - 5. Do not use neck or duct connection sizes indicated to size diffusers.
- D. Circular, Square and Rectangular Diffusers:
 - 1. Complete with volume control damper and adjustable equalizing grid, fabricated of same material and with same finish as diffuser.
 - 2. Damper shall be adjustable by means of operator handle and rod device, which is designed to be locked in any position , and is operable from diffuser face.
 - 3. Diffusers installed in plaster ceilings shall have plaster grounds of same material and finish as diffuser.
 - 4. Institutional Air Diffusers: Fixed stationary type with 18 gage perforated face plate welded to frame, and 3/16 inch holes on 1/4 inch staggered centers.
 - a. Supply Diffusers: 4-way deflection.
 - b. Return diffusers: No deflection.
- E. Linear Diffusers:
 - 1. Complete with opposed blade flow equalizing damper that is adjustable to any desired setting, and fabricated of same material and with same finish as diffuser.
 - 2. Damper operable from diffuser face.

2.03 DAMPERS

- A. Control Dampers (Galvanized Steel):
 - 1. Types:
 - a. Standard Damper: 40 cfm/sq ft maximum leakage rate at 1500 fpm and 1 inch wg for 48 inch wide damper (based on AMCA 500).
 - b. Low Leakage Damper: 3.7 cfm/sq ft maximum leakage rate at 1500 fpm and 1 inch wg for 48 inch wide damper (based on AMCA 500).

2. Frame: 16 gage galvanized steel hat channel with corner braces, and welded joints.
 - a. Frame Size:
 - 1) Dampers 13 inches high and under: 3-1/2 inch x 3/8 inch top and bottom frames.
 - 2) Dampers over 13 inches high: 5 inch x 1 inch.
 3. Blades:
 - a. Standard Damper: Single skin, 16 gage galvanized steel with longitudinal reinforcing grooves. Single blade dampers are acceptable for ducts up to 14 inches high.
 - b. Low Leakage Damper: Single skin, 16 gage galvanized steel with longitudinal reinforcing grooves, and PVC coated polyester blade edge seals mechanically locked into blade edge.
 - c. Blade Action:
 - 1) Modulating Dampers: Opposed blade.
 - 2) Fully Open/Fully Closed Dampers: Parallel blade.
 - e. Single blade dampers are acceptable for ducts up to 14 inches high.
 4. Axles: 1/2 inch plated steel hex positively locked to blade, and connected to frame through extruded hole with molded synthetic sleeve bearings.
 5. Extended Shaft Assembly: Consisting of outboard support bracket, extended shaft rod, extended shaft.
 - a. Suitable for 2 inches of insulation.
 6. Jamb Seals: Flexible metal compression type.
 7. Damper Operation:
 - a. Standard Damper: Manually operated by lockable hand quadrant.
 - b. Low Leakage Dampers: Electric motor operated. Weld actuator mounting bracket to frame.
 8. Linkage:
 - a. Single Section Dampers: In-frame fixed type with removable 1/2 inch dia control shaft extending 6 inches from damper frame, and outboard support bearing.
 - b. Multiple Section Dampers: On-blade fixed type with factory installed jackshaft.
 9. Finish: Mill galvanized.
- B. Control Dampers (Aluminum):
1. Types:
 - a. Standard Damper: 3.2cfm/sq ft maximum leakage rate at 2000 fpm and 1 inch wg for 48 inch wide damper (based on AMCA 500).
 - b. Low Leakage: 2.7 cfm/sq ft maximum leakage rate at 4000 fpm and 1 inch wg for 48 inch wide damper (based on AMCA 500).
 2. Frame: Extruded aluminum hat channel, 1/8 inch thick, and mounting flanges, and welded joints.
 - a. Frame Size:

- 1) Dampers 12 inches high and under: 5 inches x 1/2 inch top and bottom frames.
 - 2) Dampers over 12 inches high: 5 inches x 1 inch
 3. Blades:
 - a. Standard Damper: Constructed of 1/8 inch thick extruded aluminum with replaceable extruded vinyl double edge blade seals mechanically locked into extruded blade slots.
 - b. Low Leakage Damper: Airfoil type constructed of 0.71 thick extruded aluminum, with integral reinforcing tube running full length of blade, and replaceable extruded vinyl double edge blade seals mechanically locked into extruded blade slots.
 - c. Blade Action:
 - 1) Modulating Dampers: Opposed blade.
 - 2) Fully Open/Fully Closed Dampers: Parallel blade.
 - d. Single blade dampers are acceptable for ducts up to 14 inches high.
 4. Axles: 1/2 inch plated steel hex positively locked to blade and connected to frame through extruded hole with molded synthetic sleeve bearings.
 5. Extended shaft Assembly: Consisting of outboard support bracket, extended shaft rod, and extended shaft.
 - a. Suitable for 2 inches of insulation.
 6. Jamb Seals: Flexible metal compression type.
 7. Damper Operation:
 - a. Standard Damper: Manually operated by lockable hand quadrant.
 - b. Low Leakage Dampers: Electric motor operated. Weld actuator mounting bracket to frame.
 8. Linkage:
 - a. Single Section Dampers: In-frame fixed type with removable 1/2 inch dia control shaft extending 6 inches from damper frame.
 - b. Multiple Section Dampers: On-blade fixed type with factory installed jackshaft.
 9. Finish: Mill.
- C. Insulated Control Dampers:
1. Frame: 16 gage galvanized steel hat channel, minimum 4 inches wide, with corner braces, and welded joints.
 2. Blades: Double skin, 16 gage galvanized steel insulated with one inch thick fiberglass, with vinyl edge seals, and longitudinal reinforcing grooves.
 3. Blade Action:
 - a. Volume Control Dampers: Opposed blade.
 - b. Fresh Air and Make-up Air Control Dampers Interlocked with Exhaust Fans: Parallel blade.
 4. Axles: Minimum 7/16 inch plated steel hex positively locked to blade, and connected to frame through extruded hole with molded synthetic sleeve bearings.

5. Extended Shaft Assembly: Consisting of outboard support bracket, extended shaft rod, extended shaft.
 - a. Suitable for 2 inches of insulation.
 6. Jamb Seals: Flexible metal compression type.
 7. Damper Operation: Electric motor operated. Weld actuator mounting bracket to frame.
 8. Linkage:
 - a. Single Section Dampers: In-frame fixed type with removable 1/2 inch dia control shaft extending 6 inches from damper and outboard support bearing.
 - b. Multiple Section Dampers: On-blade fixed type with factory installed jackshaft.
 9. Finish: Mill galvanized.
- D. Fire Dampers, Dynamic Systems:
1. UL Classified and Labeled:
 - a. Mark dampers in accordance with UL555, including but not limited to the following:
 - 1) Fire Damper, 1-1/2 hr fire resistance rating.
 - 2) For use in dynamic systems.
 - 3) Maximum rated air flow and pressure difference across damper.
 - 4) Directional arrow indicating air flow.
 - 5) Mounting position (horizontal or vertical, or both).
 2. Acceptable Manufacturers:
 - a. Air Balance, Inc., or Ruskin Manufacturing Div., Phillips Industries.
 - 1) Furnish Style, or Type B (blades out of air stream when damper in open position).
- E. Multiple Blade Type Combination Fire/Smoke Dampers:
1. UL Classified and Labeled:
 - a. Fire Resistance Rating 1-1/2 hr.
 - b. Leakage Classification: _____.
 - c. Degradation Test Temperature: _____ degrees F.
 2. Actuator: Electric motor with fusible link override.
- F. Manual Damper Regulators:
1. For Dampers Installed in Exposed, or Accessible Concealed Ductwork: Indicating quadrant with heavy metal handle, end bearing, and means for locking damper in all positions.
 2. For Dampers Installed in Inaccessible Concealed Ductwork: Concealed type with indicating regulator in cast metal box with cover plate. Furnish assembly complete with duct end bearing, adjustment coupling, and damper extension rods.

2.04 COMBINATION DAMPERS AND LOUVERS

- A. Construction: Extruded 6063T5 aluminum, with the following:

1. Frame: 6 inches deep x 0.125 inches wall thickness.
2. Front Blades: Stationary, drainable type, 0.081 inches thick. Set blades at 37-1/2 degrees on 4-1/2 inch centers
3. Rear Blades: Adjustable type, 0.125 inches thick.
4. Seals: Vinyl damper blade edge seals and flexible, compressible aluminum jamb seals.
5. Damper Bearings: Stainless steel.
6. Electric motor operator with auxiliary (end) switch on motor.
7. Finish: Clear anodized finish.
8. Bird Screen: Aluminum wire mesh.

2.05 DAMPER ACTUATORS

- A. Acceptable Manufacturers: Honeywell Inc., Johnson Controls, Inc., Belimo, and Siemens.
- B. Electric/Electronic Type:
 1. Positive positioning, spring return, and sized in accordance with actuator manufacturer's printed recommendations for each damper size.
 2. Actuators for outdoor dampers shall fail closed upon loss of electric power.
 3. Actuator Response: Linear in response to sensed load.
 4. Voltage: 120 VAC or 24 VAC.
 5. Actuator Timing:
 - a. Open Damper: 90 seconds.
 - b. Spring Return: 30 seconds.
 - c. Spring Close: 30 seconds.
- C. Pneumatic Piston Type: Sized in accordance with actuator manufacturer's printed recommendations for each damper size.
 1. Operating Pressure: 3-15 psig.
 2. Two-way swivel connection on cylinder.
 3. Swivel ball joint and slotted crank arm.
 4. Universal mounting bracket.
- D. Hydraulic, thermodynamic and battery type actuators are not acceptable.
- E. Auxiliary End Switches: Required on electric/electronic actuators for the following applications:
 1. 100 percent Outside Air Systems: Outside air damper switch delays start of unit until damper is open. Set switch to start unit when damper is 50 percent open.
 2. In-line Exhaust Fan Systems (Over 500 cfm): Exhaust damper switch delays start of fan until damper is open.
- F. Dampers associated with diesel alternators shall be spring open, power closed.

2.06 TURNING VANE ASSEMBLIES

- A. Fabricate vane assemblies of same material as ductwork in which installed.
 1. Vanes: Individual hollow airfoil type, rigidly connected to vane rails.

2. Weld, screw, or rivet rails to ductwork.

2.07 FLEXIBLE CONNECTIONS - FABRIC

- A. Static Pressures under 6 inches WG: Woven Fiberglass fabric with Hypalon coating; similar to Duro Dyne Corp.'s Durolon.
- B. Static Pressures 6 inches and Above: Single ply neoprene reinforced with 14 oz duck fabric; Style 3210 by Uni Rubber Inc., 11 Park Place, New York, NY 10007, (212) 962-0980.
 1. Attach fabric to minimum one inch wide 11 gage stiffener, and seal with duct sealant.
- C. Direct Fired Heating Equipment with Temperatures up to 500 Degrees F: Woven fiberglass fabric with silicone rubber coating; similar to Duro Dyne Corp.'s Thermofab.
- D. Factory prefabricated and pre-assembled connectors of fabric materials specified above are acceptable with minimum 24 gage galvanized steel edges similar to Duro Dyne Corp.'s Metal-Fab or Super Metal-Fab as required by free fabric length.

2.08 GASKET MATERIAL

- A. Registers, Grilles, and Diffusers Installed in Exposed, Uninsulated Ductwork: 1/4 inch thick felt or sponge rubber material, of width as required by flange.
- B. Flanged Joints in Ducts: 1/8 inch thick reinforced inert plastic of the self-conforming type, of same width as flange.
 1. Exception: Where flanged connections in cooking equipment exhaust ductwork is allowed by NFPA 96, make up joints with Fibrefrax Grade 110 Paper by Carborundum Co.

2.09 SEALANTS

- A. Acceptable Manufacturers: Duro Dyne Corp.; Foster Products Div., H.B. Fuller Co.; Hardcast Inc.; United Sheet Metal Div., United McGill Corp.
- B. U.L. Listed adhesives (liquid or mastic), scrim, tapes, or combinations thereof, as required for pressure class; suitable for system operating temperatures; compatible with media conveyed within, insulation (if any), and ambient conditions.

2.10 FLEXIBLE DUCT

- A. Conform to NFPA 90A, and UL181 Class I:
 1. Uninsulated Type: Factory assembled duct consisting of continuous, seamless, metalized polyester tear resistant duct with encapsulated steel helix.
 2. Pre-insulated Type: Factory assembled.

- a. Internal Core: Continuous material suitable for service, with encapsulated steel helix that completely shields fiberglass insulation from air stream.
 - b. Outer Vapor Barrier Jacket: Seamless, tear resistant metalized polyester.
3. Operating Conditions:
 - a. Maximum Operating Temperature: 180 degrees F.
 - b. Maximum Operating Static Pressure (Positive): 2 inch wg.
 - c. Maximum Operating Static Pressure (Negative): .5 inch wg.
 - d. Maximum Air Velocity: 2000 fpm.
4. Metal Clamps: Stainless steel with cadmium plated hex bolt.

2.11 DUCT ACCESS DOORS

- A. Prefabricated or Fabricated at Site: Minimum 12 x 12 inch size, of same material and finish as duct unless otherwise shown or specified.
 1. For uninsulated duct designed for under two inches wg: Fabricate single panel door of same gage as duct, with all edges folded, size door to overlap opening perimeter by one inch.
 2. For insulated duct and duct designed for two inches wg and over: Fabricate hollow metal doors in accordance with the SMACNA Manual. Fill void in doors for insulated duct with thermally equivalent insulation.
 3. Gasketing: A 3/4 inch wide, 1/8 inch thick urethane gasket, around all four sides of duct opening.
 - a. Exception: Where access doors are required by NFPA 96 in cooking equipment exhaust ductwork, gasket with Fibrefrax Grade 110 paper by Carborundum Co.
- B. Access Door Hardware:
 1. Piano Hinges: Galvanized steel with brass pins, continuous type, full height of door.
 2. Butt Hinges: Galvanized steel with brass pins, approximately 2 inches x 1-9/16 inches wide for doors under 24 inches high and 3 inches x 2 inches wide for doors over 24 inches and higher.
 3. Sash Locks: Galvanized, cadmium plated, or aluminized steel or cast aluminum.
 4. Door Latches: Ventfabrics, Inc. Ventlock No. 260 or Duro Dyne Corp. Code No. SP-20 Series.

2.12 FUSIBLE LINK ATTACHMENTS

- A. For Registers and Grilles: Factory installed spring arrangement with 160 degree F rated fusible links.
- B. Thermally and Electrically Responsive Links: Air Balance's ETL electrothermal link.

2.13 FASTENERS

- A. Security Fasteners: Torx head with center pin.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Unless otherwise shown or specified, install the Work of this Section in accordance with the manufacturer's printed installation instructions and the SMACNA Manual.

3.02 FLEXIBLE FABRIC CONNECTORS (INSTALLATION)

- A. Make ductwork connections to air handling equipment with flexible fabric connectors. Install connectors with sufficient slack to prevent vibration transmission.
- B. Free Fabric Length: Install fabric connectors a minimum of three inches in length for ducts having a maximum diameter of 18 inches, or maximum side dimension of 30 inches, and a minimum of five inches in length for duct diameters over 18 inches or side dimensions over 30 inches.
- C. Secure fabric connectors to fans, casings and ducts as follows:
 - 1. Round Connectors: Secure with No. 12 USS gage x 1 inch wide galvanized steel draw bands. Secure bands with bolts and nuts.
 - 2. Rectangular Connectors: Secure with 1 inch x 1/8 inch thick flat galvanized steel bars, with screws or bolts on maximum 8 inch centers, or with approved sheet metal slip joints. Tightly crimp fabric into sheet metal joint and secure complete joint with sheet metal screws on maximum 6 inch centers.
- D. Fabric connectors may be factory pre-fabricated pre-assembled units, with minimum No. 24 USS gage metal edges, secured to fabric with double lock seams.
- E. Do not paint fabric connectors.

3.03 ACCESS DOORS

- A. Install gasketed access doors in ductwork at each of the following:
 - 1. Major changes of direction in horizontal ducts connected to cooking equipment hoods.
 - 2. Motor operated dampers.
 - 3. Manually operated volume control devices.
 - 4. Fire dampers.
 - 5. Combination fire/smoke dampers.
 - 6. All locations where operating parts of any kind are installed and elsewhere as indicated.
 - 7. In-line damper actuators installed in air stream.
 - 8. Access points for duct cleaning operations.

- B. Access doors are not required, where a manually operated damper has an exposed damper regulator, with an indicating quadrant.

3.04 CONCEALED DAMPER REGULATORS

- A. Imbed box in, and secure to back-up construction in ceiling or wall, so cover plate is flush with final surface.

END OF SECTION

SECTION 233415

CENTRIFUGAL AND IN-LINE FANS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Vibration Isolation: Section 230550.
- B. N/A
- C. N/A
- D. Motors and Motor Controllers: Section 260221.
- E. Basic Electrical Materials and Methods: Section 260501.
- F. Wiring for Motors and Motor Controllers: Section 260523.

1.02 SUBMITTALS

- A. Product Data: Catalog sheets, including rated capacities of each unit, dimensional data, operating weights, accessories, material finishes, and installation instructions.
- B. Quality Control Submittals:
 - 1. Certified fan performance curves.
- C. Contract Closeout Submittals:
 - 1. Operation and Maintenance Data: Deliver 2 copies covering the installed products, to the Director's Representative.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Each fan shall bear AMCA Seal indicating that fans comply with AMCA 211, Certified Ratings Program - Air Performance, and AMCA 311, Certified Sound Ratings Program for Air Moving Devices.
 - 2. Operating Limits: Classify according to AMCA 99-2408.
 - 3. Sound power level ratings shall comply with AMCA Standard 301, Method for Calculating Fan Sound Ratings from Laboratory Test Data.
 - 4. Electrical components shall be UL listed and labeled.

1.04 REFERENCES

- A. ABMA: American Bearing Manufacturer's Association (formerly AFBMA).
- B. AMCA: Air Movement and Control Association.

- C. ASHRAE: American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled units to the extent allowable by shipping limitations, with protective crating and coverings.
- B. Disassemble and reassemble units as required for movement to the final locations in accordance with manufacturer's printed instructions.
- C. Lift and support units at the manufacturer's designated lifting or supporting points.

PART 2 PRODUCTS

2.01 ACCEPTABLE FANS

- A. Greenheck Fan Co., PO Box 410, Schofield, WI 54476, (715) 359-6171, www.greenheck.com
 - 1. Direct Drive Fans: Model SQ.
 - 2. Belt Drive Fans: Model BSQ.
- B. Penn Barry Ventilation, 1401 North Plane Road, Richardson, TX 75081, (972) 234-3202, www.pennbarry.com.
 - 1. Direct Drive Fans: Model Centrex Inliner SX.
 - 2. Belt Drive Fans: Model Centrex Inliner SX.
- C. Loren Cook Co., P.O. Box 4047, Springfield, MO 65808, (417) 869-6474, www.lorencook.com.
 - 1. Direct Drive Fans: Model SQI-D.
 - 2. Belt Drive Fans: Model SQI-B.

2.02 CENTRIFUGAL IN-LINE FANS

- A. Housing: Rigid galvanized steel structural members and galvanized steel panels.
 - 1. Inlet Cones: Deep spun or die formed type.
 - 2. Inlet and Discharge Duct Collars: Angle flanges, with drilled or punched holes at uniform intervals, extending beyond the housing to provide continuous duct connections
 - 3. Support Angles: Heavy gage steel, shipped loose, for installing vibration isolation or bolting unit to solid foundation.
 - 4. Housing Insulation: One inch thick fiberglass duct liner.
 - 5. Vibration Isolation: Isolates motor assembly from fan housing.
 - 6. Removable Access Panels: Galvanized steel with neoprene gaskets, minimum of 2 required.
- B. Centrifugal Fan Wheel: Statically and dynamically balanced backward inclined type constructed of aluminum, spark resistant, non overloading, and matched with deeply spun venturis.

- C. Direct Drive Motor: Directly connected, totally enclosed fan cooled, continuous duty, permanently lubricated, multi-speed type with thermal overload protection.
 - 1. Wired to external junction box.
- D. Belt Drive Motor: Open drip proof, continuous duty, ball bearing design, permanently lubricated, and mounted out of the main air stream.
 - 1. Shafts: Steel, turned, ground, polished, and rust protected.
 - 2. Ball Bearings: Heavy duty, cast iron pillow block type rated for minimum L50 life exceeding 200,000 hours, 100 percent factory tested.
 - 3. Pulleys: Adjustable, cast iron, machined and keyed, and sized for 150 percent of horsepower at its rated maximum speed.
 - 4. Motor Cover and Belt Guard: Galvanized steel construction with one inch thick fiberglass duct liner.
 - 5. Wired to external junction box.
- E. Disconnect Switch: Unit mounted, UL approved for the use, non-fused safety type, NEMA 1 enclosure, factory wired from motor to external junction box.
- F. Speed Controller: Unit mounted, solid state, variable speed type, capable of altering high speed of direct drive motor by 50 percent.
- G. Dampers:
 - 1. Types:
 - a. Automatic self-opening back draft type, with spring actuated return.
 - b. Low Leakage motorized type.
 - 2. Frame: Steel.
 - 3. Blades: Aluminum.
 - 4. Bearings: Bronze or nylon.
 - 5. Blade Edge Seals: Vinyl.
 - 6. Jamb Seals: Flexible metal compression type.
- H. Fan Guards: Galvanized steel welded wire or expanded metal, with galvanized steel frame.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of fans. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install fans in accordance with manufacturer's printed installation instructions.
- B. Ceiling Suspended Fans: Suspend fans from building construction with vibration isolation devices. See Section 230550.
- C. Support fans independent from ductwork. See Section 233300 or 233301.

- D. Install units with clearances for service and maintenance.
 - 1. Provide clearance for complete wheel, motor and shaft removal.

3.03 FIELD QUALITY CONTROL

- A. Inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Pre-start Up:
 - 1. Remove shipping blocking, and bracing.
 - 2. Verify lubrication for grease bearings and other moving parts.
 - 3. Set dampers in connected ductwork in proper position.
- C. Start Up:
 - 1. Energize motor, verify proper operation of drive system, and fan wheel.

END OF SECTION

SECTION 233422

PROPELLER FANS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Wiring for Motors and Motor Controllers: Section 260523.
- B. Motor and Motor Controllers: Section 260221.

1.02 SUBMITTALS

- A. Product Data: Manufacturer's catalog sheets, performance charts, standard schematic drawings, specifications and installation instructions for each size and type fan.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Fans with wheels 12" in size and larger shall be licensed to bear the AMCA seal.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sheet Metal:
 - 1. Galvanized Sheet Steel: ASTM A 653, coating designation G90.
 - 2. Cold Rolled Steel: Carbon steel, commercial quality - ASTM A 366.
Sheet steel shall be degreased, cleaned and phosphatized in the factory of the fan manufacturer or mill phosphatized.

2.02 FANS

- A. Types:
 - 1. HVLS fans.
 - 2. Ceiling fans.
- B. General Design: Quiet operating, electric motor driven, direct drive fan, with balanced impeller. Provide permanently lubricated bearings, allowing operation in a horizontal or vertical position. Provide fan blades of the air foil type, fabricated from aluminum, steel, wood, or composites. (As per manufacturer.)
- C. Components:
 - 1. Fabricate of fans in accordance with manufacturer specifications.
 - 2. Control of fans as per manufacturer, unless supplying custom control of fans.
 - 3. Finish of fans as specified on drawings.

D. Mounting:

1. Mount all fans as to properly support them structurally.
2. Mount all fans as per manufacturers standards and recommendations.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install fans of type and size as indicated on drawings. Installation of fans as per manufacturer instructions.

END OF SECTION

SECTION 234100

AIR FILTERS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Rooftop Air Conditioners: Section 237413.

1.02 REFERENCES

- A. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- B. UL 900 - Test Performance of Air Filter Units.
- C. ASHRAE 52.2 - Method of Testing Air Cleaning Devices used in General Ventilation for Removing Particulate Matter.
- D. IEST: Institute of Environmental Science & Technology, Recommended Practice, IEST-RP-CC001.4, Testing HEPA/ULPA Filters.

1.03 DEFINITIONS

- A. MERV: Minimum Efficiency Reporting Value.

1.04 SUBMITTALS

- A. Product Data: Catalog sheets and specifications for each type filter.

1.05 QUALITY ASSURANCE

- A. Regulatory Requirements: Supply air filters that are UL listed, Class 2.
- B. Regulatory Requirements: Supply air filters that are UL listed, Class 1.

1.06 MAINTENANCE

- A. Extra Materials: One spare set of air filters for each air handling unit utilizing air filters. Deliver spare filters to the Director's Representative in the manufacturer's original boxes, labeled as to filter usage.

PART 2 PRODUCTS

2.01 AIR FILTER TYPES

- A. Panel Air Filters: Viscous impingement type with an efficiency of MERV 5 when tested in accordance with ASHRAE 52.2, UL Class 2.
 - 1. Maximum Initial Pressure Drop: 0.12 inch wg at 300 fpm.

2. Construction: One inch thick fibrous glass media placed between perforated metal retainers, and internally bonded to both sides of one piece heavy duty kraft fiberboard or chip board enclosing frame.
 3. Acceptable Filters:
 - a. Airguard Facet Type F312.
 - b. American 5700.
 - c. Camfil Farr Cam-Glass.
 - d. Flanders/Precisionaire HD Industrial Grade.
 - e. Glasfloss Disposable Panel Filter.
 - f. Purolator Facet-Aire 3.
- B. Pleated Air Filters: Extended surface medium efficiency air filter having a MERV of 7 when tested in accordance with ASHRAE Standard 52.2.
1. Maximum Initial Pressure Drop:
 - a. 1 inch thick filters: 0.45 inch wg at 500 fpm.
 - b. 2 inch thick filters: 0.28 inch wg at 500 fpm.
 - c. 4 inch thick filters: 0.27 wg at 500 fpm.
 2. Construction (UL Class 2 Filters):
 - a. Filter Media: Non-woven blend of cotton and synthetic fibers bonded on the air exiting side to welded wire support grid formed to maintain pleat configuration.
 - b. The wire grid support treated for corrosion resistance.
 - c. Enclosing Frame: Constructed of high wet-strength moisture resistant beverage board or chipboard, with diagonal support members bonded the apex of each pleat on the air entering and air exiting sides of filter pack.
 - d. Filter pack bonded to enclosing frame around the entire periphery of the frame.
 3. Acceptable Filters (UL Class 2 Filters):
 - a. Airguard: Type DP-2-40.
 - b. American 300X.
 - c. Camfil Farr 30/30.
 - d. Flanders/Precisionaire Pre-Pleat HV.
 - e. Glasfloss Z-Line HV.
 - f. Purolator Mark 80.
 4. Construction (UL Class 1 Filters):
 - a. Filter Pack: Constructed of microfiber glass laminated to an all-glass mesh backing material.
 - b. Media: Formed into tapered radial pleats and bonded to a welded wire support grid formed to maintain pleat configuration.
 - c. Enclosing Frame: Constructed of non-flammable board with diagonal support members bonded to each pleat apex on both sides of filter pack; or a galvanized expanded metal media support retainer on the downstream side.
 - d. Filter pack bonded to enclosing frame around entire inside periphery of frame.
 5. Acceptable Filters (UL Class 1 Filters):
 - a. Airguard: Type DP Class 1.
 - b. American AmAir HT.
 - c. Camfil Farr 30/30 UL Class 1.

- C. Bag Air Filters: Non-supported, deep pleated, extended surface type with average efficiencies based on ASHRAE 52.2, and capable of operating to maximum of 625 fpm without impairing efficiency.
1. Maximum Initial Pressure Drop at 500 feet per minute:
 - a. MERV 9-10 filters: 0.18 inch wg.
 - b. MERV 11 filters: 0.25 inch wg.
 - c. MERV 13 filters: 0.40 inch wg.
 - d. MERV 14 filters: 0.60 inch wg.
 2. Construction (UL Class 2 Filters):
 - a. Individual pockets constructed of high-density fibrous glass media reinforced with a non-woven media support backing.
 - b. Stitched joints sealed with a hot melt adhesive.
 - c. Each pocket includes internal pocket spacer threads to ensure tapered pockets.
 - d. Number of pockets consistent with required airflow and pressure drops previously listed.
 - e. Pockets held in place by steel pocket retainers securely attached to a peripheral header for side-access of built-up bank installation.
 3. Acceptable Filters (UL Class 2 Filters):
 - a. Airguard Venti-Pak.
 - b. American Dri-Pak.
 - c. Camfil Farr Hi-Flo.
 - d. Flanders/Precisionaire Precision Pak Fiberglass.
 - e. Glasfloss Purapak.
 - f. Purolator Serva-Pak (fiberglass).
 4. Construction (UL Class 1 Filters):
 - a. Individual pockets constructed of high-density fibrous glass reinforced with non-woven fire resistant backing.
 - b. Stitched joints sealed with a fire resistant adhesive.
 - c. Each pocket shall include internal pocket spacer threads to ensure tapered pockets.
 - d. Number of pockets consistent with required airflow and pressure drops previously listed.
 - e. Pockets held in place by steel pocket retainers securely attached to a peripheral header for side-access of built-up bank installation.
 5. Acceptable Filters (UL Class 1 Filters):
 - a. Airguard Vento-Pak UL Class 1.
 - b. American Air DriPak 2000.
 - c. Camfil Farr Hi-Flo UL Class 1.
 - d. Flanders/Precisionaire Precision Pak Fiberglass UL Class 1.
 - e. Purolator Serva-Pak UL Class 1.
- D. Rigid Air Filters: Extended surface, deep pleated type with average efficiencies based on ASHRAE 52.2.
1. Maximum Initial Pressure Drop for UL Class 2:

FILTER EFFICIENCY	MAXIMUM INITIAL PRESSURE DROP FOR 6 INCH THICK FILTERS (inch wg at 300 fpm)	MAXIMUM INITIAL PRESSURE DROP FOR 12 INCH THICK FILTERS (inch wg at 500 fpm)
MERV 9	0.08	0.20
MERV 11	0.24	0.29
MERV 13	0.41	0.50
MERV 14	0.56	0.68

2. Construction (UL Class 2 Filters):
 - a. Filter Pack: Constructed of high-density microfine glass fibers laminated to a synthetic backing material, and bonded to a welded wire grid that is post treated to be corrosion resistant.
 - b. Pleat configuration maintained by pleat supporting members installed on both air entering and air exiting sides.
 - c. Filter pack enclosed and continuously sealed to a galvanized steel enclosing frame, and supported by diagonal members attached to pleat supporting members on the air entering and air exiting sides.
3. Acceptable Filters (UL Class 2 Filters):
 - a. Airguard: Vari-Pak.
 - b. American Varicel RF.
 - c. Camfil Farr Riga-Flo.
 - d. Flanders/Precisionaire Rigid Air Fiberglass.
 - e. Glasfloss Z-Pak Fiberglass.
 - f. Purolator Aero-Cell (fiberglass).
4. Maximum initial pressure drop for UL Class 1:

FILTER EFFICIENCY	MAXIMUM INITIAL PRESSURE DROP FOR 6 INCH THICK FILTERS (inch wg at 250 fpm)	MAXIMUM INITIAL PRESSURE DROP FOR 12 INCH THICK FILTERS (inch wg at 500 fpm)
MERV 11	0.15	0.45
MERV 13	0.30	0.60
MERV 14	0.35	0.65

5. Construction (UL Class 1 Filter):
 - a. Filter Media: One continuous sheet of microfine wet-laid glass mat media.
 - b. Media separators of corrugated aluminum construction to provide media separation and to promote uniform airflow.
 - c. The filter pack shall be sealed on all four sides to prevent air bypass.
 - d. Enclosing Frame: Galvanized steel with an integral 1" nominal size header for installation into side-access housings or built-up filter bank frames.
6. Acceptable Filters (UL Class 1 Filters):
 - a. Airguard Variflow VSC-MB.

- b. American Varicel.
- c. Camfil Farr Aeropac.
- d. Flanders/Precisionaire Precision Cell.
- e. Glasfloss Magna Series.
- f. Purolator: Serva-Cell.

E. V-Bank Rigid Filters: High-capacity V-Style final filters, UL Class 2, with average efficiencies based on ASHRAE 52.2.

1. Maximum Initial Pressure Drop:

FILTER EFFICIENCY	MAXIMUM INITIAL PRESSURE DROP FOR 12 INCH THICK FILTERS (inch wg at 500 fpm)
MERV 11	0.27
MERV 13	0.35
MERV 14	0.38

2. Construction:

- a. Filter Media: Microfine glass formed into uniformly spaced pleats, separated by glass filaments, and formed into multiple minipleat packs.
- b. Minipleat packs shall be assembled into a v-bank configuration with the appropriate number of packs to obtain the required pressure drop.
- c. The packs shall be continuously bonded into the periphery of a high-impact fire resistant enclosing frame.
- d. A peripheral header for installation into side-access housings or built-up filter banks.
- e. A gasket on one side of peripheral header to eliminate air bypass between filters.

3. Acceptable Filters:

- a. Airguard Vari+Plus VP.
- b. American Varicel V.
- c. Camfil Farr Durafil 4V.
- d. Flanders/Precisionaire Superflow V.
- e. Purolator Serva-Cell VA.

F. HEPA Filters:

- 1. The filter shall have a tested efficiency of (99.97% on 0.3 micron when evaluated according to IEST Recommended Practice.
 - a. Maximum Initial Resistance to Airflow: 1.0" wg at rated capacity.
- 2. Filter shall be listed by Underwriters Laboratories as UL 900 Class 2.
- 3. The filter shall be capable of withstanding 10" wg without failure of the media pack.
- 4. Manufacturer shall provide evidence of facility certification to ISO 9001:2000.
- 5. The filter shall be labeled as to tested efficiency, rated/tested cfm, pressure drop and shall be serialized for identification.
- 6. Construction:

- a. Filter Pack: Filter media shall be one continuous pleating of micro glass fiber media.
 - b. Media Separators: Pleats shall be uniformly separated by tapered corrugated aluminum separators incorporating a hemmed edge to prevent damage to the filter media.
 - c. Filter Pack Sealant: The media pack shall be potted into the enclosing frame with a fire-retardant urethane sealant.
 - d. Enclosing Frame: 16-gauge steel, with a zinc-aluminum alloy finish, and shall be bonded to the media pack to form a rugged and durable enclosure.
 - e. The filter shall be assembled without the use of fasteners to ensure no frame penetrations.
 - 1) Overall dimensional tolerance shall be correct within - $1/8'' \pm 0''$, and square within $1/8''$.
 - f. A sealing gasket shall be included on the downstream side of the filter enclosing frame to form a positive seal upon installation (50 % gasket compression).
7. Acceptable Filters:
- a. Airguard Microguard 99.
 - b. American Air Filter AstroCel 1.
 - c. Camfil Farr XS Absolute.
 - d. Flanders/Precisionaire Alpha Cell.
 - e. Glasfloss Magna Series 1000.
 - f. Purolator Ultra-Cell.

2.02 MULTIPLE FILTER BANK ASSEMBLIES (BUILT UP FILTER BANKS)

- A. Filter Holding Frame: Constructed of 16-gauge galvanized steel, assembled from two corner sections, and welded to assure a rigid and durable frame assembly.
- B. The filter holding frame to include the following:
 1. Pre-punched lances for filter fastener attachment.
 2. Filter fasteners capable of installation without use of tools, nuts, or bolts.
 3. Lance penetrations upstream of filter flange to assure leak-free integrity.
 4. Filter centering dimples on each frame wall to facilitate ease of filter installation and assure filter centering against filter sealing flange.
 5. Filter-Sealing Flange: Integral component of the holding frame with flush mitered corners, 3/4 inch wide.
 6. Filter Sealing Flange Gasket: Permanently mounted polyurethane foam on the filter sealing flange to assure filter to frame sealing integrity.

2.03 SIDE LOADING FILTER HOUSINGS

- A. Housing: Weatherproof type suitable for rooftop/outdoor installation, and capable of two stages of filtration without requiring any modification to the housing.
 1. Construction: 16-gauge galvanized steel with pre-drilled standing flanges to facilitate attachment to other system components.
 2. Corner Posts: Z-channel construction shall ensure dimensional adherence.

3. Filter Track: Integral component of housing, constructed of aluminum, and capable of accommodating any of the following:
 - a. 2" deep prefilter.
 - b. 6" or 12" deep rigid final filter.
 - c. Bag filter with header.
4. Dual Access Doors: Swing-open type with high-memory sponge neoprene gasket to facilitate a door-to-filter seal, adjustable and replaceable positive sealing UV-resistant star-style knobs, and replaceable door hinges.
5. Universal Holding Frame: Constructed of 18-gauge galvanized steel, equipped with centering dimples, multiple fastener lances, and polyurethane filter sealing gasket to facilitate installation of high-efficiency filters.
6. Pneumatic Fitting: Allows for the installation of a static pressure gauge to evaluate pressure drop across a single filter or any combination of installed filters.
7. Housing Performance: Leakage at rated airflow.
 1. Upstream to Downstream of Filter, Holding Frame, and Slide Mechanism: Less than 1% at 3.0" wg
 2. Leakage into or out of the Housing: Less than 0.5% at 3.0" wg

2.04 MULTIPLE FILTER BANK ASSEMBLIES (BUILT UP HEPA FILTER BANKS)

- A. Filter Holding Frame: Constructed of 14-gauge all welded galvanized steel capable of accommodating full size 24" by 24" or half size 12" by 24" HEPA filters.
- B. The filter-holding frame to include the following:
 1. Pre-drilled mounting holes for frame-to-frame assembly.
 2. Centering dimples to assist in HEPA filter alignment.
 3. Swing-bolt assemblies for filter installation.

2.05 SIDE LOADING HEPA FILTER HOUSINGS

- A. Housing: Weatherproof type suitable for rooftop /outdoor installation and capable of two stages of filtration without requiring any modification to the housing.
 1. Construction: 14-gauge galvanized steel with pre-drilled standing flanges to facilitate attachment to other system components.
 2. Reinforced with channel bracing to withstand 8.0" wg positive or negative pressure and ensure dimensional adherence.
 3. Filter securing swing bolt assemblies with equi-bearing filter clamps to install HEPA filters into housing. There shall be a minimum of four assemblies per filter unit.
 4. Dual Access Doors: Pin-hinged removable access doors to allow access from either side of the housing. Doors shall be gasketed with high-memory gasketing to prevent leaks.
 5. Prefilter Track: Integral component of housing, constructed of aluminum, and capable of accommodating any of the following:
 - a. 2" deep prefilter.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install the Work of this section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.
- B. Filter Application Schedule for locations requiring UL Class 2 filters (most applications): Install set of filters in each air-handling unit listed below:

APPLICATION	FILTER TYPE	FILTER THICKNESS/DEPTH (inches)	UL CLASS
<u>Single-Stage Filtration:</u> Fan coil units, cabinet unit heaters, and unit ventilators.	Panel	1	2
<u>Single-Stage Filtration:</u> Factory packaged air conditioners, and heating and ventilating units.	Pleated	2	2
<u>Single-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Bag	Varies with manufacturer. Depth should be consistent with system rated airflow and initial pressure drops as specified.	2
<u>Single-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Rigid	6 or 12	2
	or V-Bank	12	2
<u>Two-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Pleated	2	2
	Bag	Varies with manufacturer. Depth should be consistent with system rated airflow and initial pressure drops as specified.	2
<u>Two-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Pleated	2	2
	Rigid	6 or 12	2
	or V-Bank	12	2
<u>Two-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Pleated	2	2
	HEPA	12	2

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APPLICATION	FILTER TYPE	FILTER THICKNESS/DEPTH (inches)	UL CLASS
<u>Three-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Pleated	2	2
	Bag	Varies with manufacturer. Depth should be consistent with system rated airflow and initial pressure drops as specified.	2
	HEPA	12	2
<u>Three-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings. banks, banks and filter housings.	Pleated	2	2
	Rigid	6 or 12	2
	or V-Bank	12	2
	HEPA	12	2

- C. Filter Application Schedule for locations requiring UL Class 1 filters (New York City): Install set of filters in each air-handling unit listed below:

APPLICATION	FILTER TYPE	FILTER THICKNESS/DEPTH (inches)	UL CLASS
<u>Single-Stage Filtration:</u> Fan coil units, cabinet unit heaters, and unit ventilators.	Pleated	1	1
<u>Single-Stage Filtration:</u> Factory packaged air conditioners, and heating and ventilating units.	Pleated	2	1
<u>Single-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Bag	Varies with manufacturer. Depth should be consistent with system rated airflow and initial pressure drops as specified	1
<u>Single-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Rigid	6 or 12	1
<u>Two-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Pleated	2	1
	Bag	Varies with manufacturer. Depth should be consistent with system rated airflow and initial pressure drops as specified.	1

APPLICATION	FILTER TYPE	FILTER THICKNESS/DEPTH (inches)	UL CLASS
<u>Two-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Pleated	2	1
	Rigid	6 or 12	1
<u>Two-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Pleated	2	1
	HEPA	12	1
<u>Three-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Pleated	2	1
	Bag	Varies with manufacturer. Depth should be consistent with system rated airflow and initial pressure drops as specified.	1
	HEPA	12	1
<u>Three-Stage Filtration:</u> Factory packaged air conditioners, heating and ventilating units, filter banks, and filter housings.	Pleated	2	1
	Rigid	6 or 12	1
	HEPA	12	1

END OF SECTION

ASHRAE 52.1-1992 EFFICIENCY	ASHRAE 52.2-1999 MERV
<20%	MERV 1-5
20-25%	MERV 6
25-30%	MERV 7
30-35%	MERV 8
40-45%	MERV 9
50-55%	MERV 10
60-65	MERV 11
70-75%	MERV 12
80-90	MERV 13
90-95%	MERV 14
~95%	MERV 15
>95%	MERV 16

MERV	TYPICAL CONTAMINANT	TYPICAL APPLICATION
1 Thru 5	Particle Size: Larger than 10	Minimum filtration, residential

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MERV	TYPICAL CONTAMINANT	TYPICAL APPLICATION
	microns; pollen, Spanish moss, dust mites, sanding dust, paint spray, dust, textile and carpet fibers.	window air conditioners.
6 thru 8	Particle Size: 3.0 to 10 microns; mold, spores, hair spray, cement dust, snuff, powdered milk.	Commercial and industrial buildings, better residential buildings, paint spray booths.
9 thru 12	Particle Size: 1.0 to 3.0 microns; Legionella, lead dust, milled flour, coal dust, auto emissions, welding fumes.	Commercial buildings, superior residential buildings, hospital laboratories, welding shops.
13 thru 16	Particle Size: 0.3 to 1.0 microns; all bacteria, most tobacco smoke, droplet nuclei, cooking oil, copier toner dust, face powder, paint pigment.	Hospital inpatient care, general surgery, smoking lounges, superior commercial buildings.

END OF INFORMATION

SECTION 235123

GAS VENTS

PART 1 GENERAL

1.01 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Roof support, roof flashing and storm collar.
- B. Furnish Construction Contractor with two sets of approved drawings showing exact location and dimensions of roof opening required for chimney pipe.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Seismic Restraints for Ductwork: Section 233113. (N/A)

1.03 SUBMITTALS

- A. Shop Drawings: Scale drawings showing prefabricated chimney components, guy wire layout, and relationship to hot water heater, equipment, and building structure including all connections.
 - 1. Submit all job specific design calculations.
- B. Product Data: Catalog sheets, specifications and installation instructions for each item supplied, including accessory items such as sealant.
- C. Contract Closeout Submittals:
 - 1. Warranty: Copy of specified Warranty.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Gas vents shall be designed and installed in accordance with the requirements of the NFPA and all components shall be UL listed and labeled for use with UL Category I gas burning appliances.
 - 2. Comply with the applicable requirements of the Sheet Metal and Air Conditioning Contractors National Association, unless otherwise shown or specified.

PART 2 PRODUCTS

2.01 MANUFACTURERS/COMPANIES

- A. Selkirk Commercial Products Group, 815 Kimberly Drive, Carol Stream, IL 60188, (800) 624-8642, www.selkirkcommercial.com.

- B. Metal-Fab Inc., P.O. Box 1138, Wichita, KS 67201, (316) 771-4154,
www.metal-fabinc.com.

2.02 TYPE B GAS VENT

- A. Acceptable Gas Vents:
1. Selkirk Models RV (3 inch thru 8 inch sizes) and Model QC (10 inch thru 48 inch sizes).
 2. Metal - Fab Model M.
- B. Type: Factory fabricated, round sectional, double walled chimney with twist lock end joints, tested in accordance with UL 441, and rated for 480 degrees F.
1. Construction:
 - a. Inner Shell:
 - 1) Sizes 3 inch thru 8 inch: 0.012 inch thick aluminum alloy.
 - 2) Sizes 10 inch thru 30 inch: 0.018 inch thick aluminum alloy.
 - b. Outer Shell:
 - 1) Sizes 3 inch thru 14 inch: 0.018 inch thick G-90 galvanized steel.
 - 2) Sizes 16 inch thru 30 inch: 0.024 inch thick aluminum alloy.
 - c. Annular Insulating Air Space:
 - 1) Sizes 3 inch thru 6 inch: 1/4 inch thick.
 - 2) Sizes 7 inch thru 30 inch: 1/2 inch thick.
- C. Chimney fittings, supports, anchor plates, roof flashing, storm collar, storm cap and other miscellaneous items shall be of the same manufacture as the chimney.
- D. Termination cap shall be of the bird proof type.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install gas vents in accordance with the manufacturer's printed installation instructions.

END OF SECTION

SECTION 235415

ELECTRIC HEATERS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Control Wiring: Section 260523.

1.02 REFERENCES

- A. Rate heaters in accordance with AMCA and ARI standards.
- B. All electrical components shall be UL listed.

1.03 SUBMITTALS

- A. Waiver of Submittals: The "Waiver of Certain Submittal Requirements" in Section 013300 does not apply to this Section.
- B. Product Data: Catalog sheets, performance charts, specifications and installation instructions.

PART 2 PRODUCTS

2.01 ELECTRIC HEATERS

- A. Casing: Provide heavy gage die stamped sheet steel casing, formed, reinforced and braced for rigidity. Furnish horizontal units with adjustable horizontal and vertical louvers, and vertical units with a radial deflector with adjustable multiple blades mounted in a cone, outside fan orifice. Fabricate louvers and deflector from sheet steel of sufficient rigidity to prevent vibration at all speeds.
- B. Heating Elements: Provide black-heat, finned steel-sheathed type, of spiral design, individually replaceable. Furnish elements complete with built-in thermal cutouts, for protection against overheating.
- C. Fan Assembly: Provide multiple blade propeller type, directly connected to a resiliently mounted electric motor, of speed or speeds as indicated. Furnish single phase motors of the capacitor, split phase or shaded pole type. Furnish assembly complete with terminal box for wiring connections and a UL approved disconnect switch mounted on heater. Furnish motor with overload devices.
- D. Factory Finish: Furnish all exposed surfaces of unit heaters, with a factory applied two coat baked enamel finish.
- E. Cabinet types or convective types as per above. (Convective types no fan/blower.)

Electric duct heaters to be installed as per manufacturers direction. Duct heaters
To be manufactured for use specified. (Indoor/damp/wet/outdoor types.)

- F. Controls for all types of electric heaters as per manufacturer and/or as specified.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install heaters at locations indicated on drawings.
- B. Support heaters from overhead construction by means of steel hanger rods, a minimum of 2 per heater, unless otherwise indicated. Support duct heaters as per duct heater manufacturer.

3.02 CONTROL

- A. Thermostatically controlled. (As specified. Can be wall mounted, unit mounted, or duct mounted.)

END OF SECTION

SECTION 235416

ERV UNITS

1. GENERAL

1.1 SUMMARY

- A. This section includes Energy Wheel Air-to-Air Energy Recovery Ventilators for [indoor] [outdoor] installation.

1.2 SUBMITTALS

- A. Product Data: For each type or model include the following:
1. Complete fan performance curves for both the supply air and exhaust air, with system operating conditions indicated, as tested in an AMCA Certified chamber.
 2. Energy wheel performance data for both summer and winter operation.
 3. Motor ratings, electrical characteristics, motor and fan accessories.
 4. Combined efficiency data per ARI Guideline V-2003 for each model. Data shall include RER, COP, Unitary Net Cooling, Unitary EER and CEF.
 5. Material types and gauges of all component pieces and assemblies.
 6. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
 7. Estimated gross weight of each installed unit.
 8. Installation, Operating and Maintenance manual (IOM) for each model.
 9. [Remote Control Panel description to include all functions.]
 10. [Color chart including a palette of available standard paint finishes.]

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain unit with all appurtenant components or accessories from a single manufacturer.
- B. For the actual fabrication, installation, and testing of work under this section, use only thoroughly trained and experienced workers completely familiar with the items required and with the manufacturer's current recommended methods of installation.
- C. Product Options: Drawings must indicate size, profiles, and dimensional requirements of Energy Recovery Units and are to be based on the specific system indicated. Refer to Division 1 Section "Product Requirements".
- D. Certifications:
1. Blowers shall be AMCA certified for airflow.
 2. Entire unit shall be ETL Certified per U.L. 1995 and bear an ETL sticker.
 3. Energy Wheel shall be AHRI Certified per Standard 1060.

1.4 COORDINATION

- A. Coordinate size and location of all building penetrations required for installation of each unit and associated plumbing and electrical systems.
- B. Coordinate sequencing of construction of associated HVAC, electrical supply [roofing contractor].

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and identified with labels describing contents.
 - 1. Filters: [(Insert quantity) set(s) of MERV 8 disposable filters for each unit].
 - 2. One set of fan belts.(If belted.)
 - 3. One set of energy wheel belts.

2. PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
 - 1. Greenheck Fan Corporation

2.2 MANUFACTURED UNITS

- A. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, [outdoor air intake weather hood with metal mesh filters], energy wheel, [motorized intake damper], [motorized exhaust damper], [sensors], [curb assembly], [service receptacle], [frost control], [electric preheater], filter assembly for intake and exhaust air, supply air blower assembly, exhaust air blower assembly and an electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.

2.3 CABINET

- A. Materials: Formed [single] [double] wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - 1. Unit's exterior shall be supplied from the manufacturer using G60 galvaneal steel with a high performance proprietary coating that has been subjected to a salt spray test per ASTM-B117 and evaluated using ASTM-D714 and ASTM-D610 showing no observable signs of rust or blistering until reaching 5,000 hours.(Hi Pro Poly Coating.)
 - 2. Internal assemblies: [18 gauge, galvanized (G90) steel] except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
- B. Access doors shall be hinged.
- C. Unit shall have factory-installed duct flanges on all duct openings.
- D. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - 1. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - a. Thickness: 1 inch (25 mm)
 - b. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.

- c. Location and application: Full coverage of entire cabinet exterior to include walls, roof and floor of unit. Insulation shall be of semi-rigid type and installed between inner and outer shells of all cabinet exterior components.
- E. Energy wheel: Energy wheel shall be of total enthalpy, rotary air-to-air type, and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned drive belt. The wheel media shall be a polymer film matrix in a stainless steel framework and be comprised of individual segments that are removable for servicing. Non-segmented energy wheels are not acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and shall be designed and constructed to permit cleaning and servicing. The energy wheel is to have a five year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.
- F. Supply Air and Exhaust Air blower assemblies: Blower assemblies consist of an electric motor and a belt driven blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on 1.125 inch thick neoprene vibration isolators.
- G. Control panel/connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections
- H. Frost control: [none] [timed exhaust] [modulating wheel] [electric preheater].
- I. Economizer Control: [None] [Stop Wheel] [Modulating Wheel] [VFD Signal by Others] [BMS Control]
- J. [Timed exhaust shall be provided for frost control of the energy wheel. Control system shall include an outdoor air thermostat and pressure sensor on the wheel assembly to initiate frost control sequence]. [Modulating frost control. Control system shall include an outdoor air thermostat and pressure sensor on the wheel assembly to initiate frost control sequence]. [Electric preheater shall be provided for frost control of the energy wheel. Preheater assembly shall include a thermostat and pressure sensor on the wheel assembly to initiate frost control sequence. Preheater shall comply with UL 1996 and be constructed on a galvanized steel frame].
- K. Motorized Dampers: Motorized dampers of [low leakage] [insulated low leakage] type shall be factory installed.
- L. Sensors are considered to be part of various optional operational modes or device controllers and are to be factory supplied and installed as specified by the Manufacturer and/or engineer..
- M. A curb assembly made of galvanized steel shall be provided by the factory for assembly and installation as part of this division. The curb assembly shall provide perimeter support of the entire unit. Curb assembly shall enclose the underside of the unit and shall be sized to fit into a recess in the bottom of the unit. Contractor shall be responsible for coordinating with roofing contractor to ensure curb unit is properly flashed to provide protection against weather/moisture penetration. Contractor shall provide and install appropriate insulation for the curb assembly].

2.4 BLOWER

- A. Blower section construction, Supply Air and Exhaust Air: Belt drive motor and blower shall be assembled onto a 14 gauge galvanized steel platform and must have neoprene vibration isolation devices.
- B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

- C. Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.
- D. Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.
- E. Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed, and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".
- F. [Exhaust Only Operation: The exhaust blower will run continuously while the supply blower is off.]

2.5 MOTORS

- A. General: Blower motors greater than $\frac{3}{4}$ horsepower shall be "NEMA Premium™" unless otherwise indicated. Minimum compliance with EPCAct minimum energy-efficiency standards for single speed ODP and TEFC enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be supplied with an adjustable drive pulley. Comply with requirements in Division 23 05 13, matched with fan load.
- B. Motors shall be 60 cycle, 3 phase 208 volts.

2.6 UNIT CONTROLS:

- A. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats, and sensors or it can be operated as a heating and cooling system controlled by a Building Management System (BMS). [This unit shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors].
- B. [Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status, operating settings, and alarm conditions. DDC controller shall have a built-in keypad to permit operator to access read-out screens and change settings without the use of ancillary equipment, devices, or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable]. Owner-specified ventilating conditions can be input by means of pushbuttons.
 - 1. [Operating protocol: The DDC shall be factory-programmed for [LonWorks] [BACnet MSTP] [BACnet IP] [Modbus RTU] [Modbus IP] for monitoring of the unit's status].
- C. [Variable Frequency Drive (VFD)]: [Unit shall have factory installed variable frequency drives for modulation of the blower motors. The VFDs shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate].
- D. [Remote Display: Contractor shall provide and install a remote display that functions as a remote indicator of owner-selected operating parameters and also permits remote inputting of new operating parameters. The remote display shall have a large LCD user interface screen similar in form and function to the screen on the DDC. Installed location of remote display shall be as indicated on the plans.

- E. Sensors
 - 1. [Room / Space Temperature Sensors]
 - 2. [Dirty Filter Sensor]
 - 3. [CO2 Sensor]
 - 4. [Temperature Sensors- [OAI], [EAW], [RAI], [OAD], [OAAW]]
 - 5. [Pressure Sensor- [OAW-P], [OAF-P], [EW-P], [EF-P]]
 - 6. [Current Sensor- [OAF-A], [EF-A]]
 - 7. [Rotation Sensor]

2.7 FILTERS

- A. [Unit shall have permanent metal filters located in the outdoor air intake and shall be accessible from the exterior of the unit]. 2" thick MERV-13 filters are to be installed in the unit.

3. EXECUTION

3.1 EXAMINATION

- A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.
- B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.
- C. Proceed with installation only after all unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, best practices, and all applicable building codes.

3.3 CONNECTIONS

- A. In all cases, industry best practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
 - 1. Duct installation and connection requirements are specified in Division 23 of this document.
 - 2. Electrical installation requirements are specified in Division 26 of this document.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage an authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A/E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed start-up checklists as found in manufacturer's IOM. (Contractor may provide this service in conjunction with manufacturer.)

3.5 START-UP SERVICE

- A. Engage an authorized service representative to perform startup service. Clean entire unit and install clean filters. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein. (Contractor may provide this service in conjunction with manufacturer.)

3.6 DEMONSTRATION AND TRAINING:

- A. Contractor to provide equipment training. Optional – Contractor may engage an authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain the entire unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

SECTION 237413

AIR CONDITIONERS – ROOFTOP (UNITARY)

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Pipe and Pipe Fittings: Section 232000.
- B. Vibration Isolation: Section 230550.
- C. Seismic Restraints: Section 230550. (N/A)
- D. Metal Ductwork: Section 233113.
- E. Air Filters: Section 234100.
- F. Temperature Control Systems: Section 230923, 230933, or 230943.
- G. Wiring for Motors and Motor Controllers: Section 260523.
- H. Motors and Motor Controllers: Section 260221.

1.02 PERFORMANCE REQUIREMENTS

- A. Design air handling unit and supports to withstand all seismic loads. Refer to seismic loading criteria on the Contract Drawings.
- B. Seismic Performance: Design and install air handling units to assure continued performance of their intended function when subjected to the specified seismic forces.
- C. Seismic Performance: Design and install air handling units to assure that they remain in place with no separation of any parts when subjected to the specified seismic forces.
- D. The design of the air handling units and supports shall be performed by a professional engineer experienced in the seismic design of air handling units.

1.02 SUBMITTALS

- A. Shop Drawings: Submit drawings for each size of factory fabricated roof curb.
- B. Product Data: Manufacturer's catalog sheets, brochures, performance charts, standard schematic drawings, specifications and installation instructions for each size unit
 - 1. Name, address, and telephone number of nearest fully equipped service organization.

- C. Quality Control Submittals:
 - 1. Copy of Seismic Qualifications Certificate.
- D. Contract Closeout Submittals:
 - 1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Director's Representative
- E. Options
 - 1. Include in submittals all optional equipment/controls called for in the equipment schedule.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Unit shall be factory tested and the design, construction and installation shall be in accordance with the following: ARI Standard 210, NFPA, UL, ASHRAE 15, Safety Code for Mechanical Refrigeration, and all State and Local codes or regulations having jurisdiction.
 - 2. Rate cooling capacities in accordance with ARI Standard 210.
 - 3. Electrical components shall be UL listed.
 - 4. Provide gas fired heating modules, for installation in combination gas fired heating and cooling units, certified by the AGA. specifically for outdoor applications.
- B. Seismic Qualification Certificate: Certificate from air handling unit manufacturer covering air handling units, accessories, supports, and components; and consisting of the following:
 - 1. Basis for Certification: Indicate whether Withstand Certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions, and loads transmitted to structure at each attachment point.
 - 3. Detailed description of equipment anchorage devices on which the certification is based including installation requirements.
 - 4. Comprehensive seismic engineering analysis of air handling units and supports.

1.04 PRODUCT DELIVERY

- A. Deliver each unit as an integral factory packaged assembly.

1.05 MAINTENANCE

- A. Maintenance Service: A fully equipped authorized service organization capable of guaranteeing response within 8 hours to service calls shall be available 24 hours a day, 7 days a week to service the completed Work.
- B. Extra Materials: Provide with each unit, one spare set of air filters. Suitable box and label spare filters as to their usage.

PART 2 PRODUCTS

2.01 AIR CONDITIONERS/HEAT PUMPS

- A. General Design: Provide combination heating and cooling units, specifically designed for installing totally exposed on roof surface. Units shall consist of a sectional type sheet metal casing, totally enclosing the heating section, supply air section, return air section, filter section, evaporator coil and fan section; condenser coil and fan section, and compressor section; all heating, refrigerant and operating controls, totally wired and complete with all internal piping and ductwork. Upon installation in their permanent locations on the roof a building, connections to service piping, electrical service and ductwork shall only be required to put units in operation.
- B. Unit Casing: Fabricate from heavy gage corrosion resistant sheet steel, properly reinforced for maximum strength and rigidity, with all welded steel angle and channel framework as required. Casing shall be of sectional construction, complete with hinged, gasketed access panels with fastening devices for ease in servicing all components. Thermally insulate the underside of the unit roof deck and all internal surfaces of casing sections in contact with return or conditioned air, with a minimum of one inch thick thermal insulation with a non-eroding surface finish. All casing joints shall be rendered watertight. Chemically pretreat and factory finish the entire casing with a corrosion-resistant enamel finish.
- C. Cooling Section: Factory sealed refrigerant system consisting of compressor, condenser and evaporator section designed for use with Refrigerant R-22.
 - 1. Compressor: Accessible, semi-hermetic, reciprocating, direct driven, constant speed, industrial type with forced feed lubrication to all bearing surfaces, utilizing a positive displacement reversible oil pump, an oil filtering system and a crank case heater. Compressor shall be provided with a suction strainer; suction, discharge and relief valves, oil sight glass and cylinders equipped with removable sleeves. Cylinders shall have safety head construction, or other means as approved, to prevent slugging. Provide aluminum pistons with plated rings. Suction and discharge valves are to be of ring plate type, constructed of alloy steel and fitted with cast iron retaining rings. Connecting rods shall be of aluminum alloy or high carbon steel, with a drilled oil passage for oil distribution to piston pins. Crank shall be cast Meehanite or forged steel with hardened cranks, with sleeve type lead bearings and thrust bearings of aluminum alloy. Motor windings shall be complete with built-in thermostatic thermal overload protection. Isolate compressor from steel casing frame construction. Provide compressor capacity control through cylinder unloading, thru four steps of capacity control.
 - 2. Condenser Section: Multiple row, seamless, copper tubing coil, with aluminum fins mechanically bonded to tubing, complete with sub-cooling circuit with liquid accumulator. Factory air test coil at 425 psig under water. Provide multiple unit direct drive condenser fan section, each fan statically and dynamically balanced, with aluminum fan blades and galvanized steel hubs. Provide heavy, permanent split capacitor fan

- motors with permanently lubricated ball bearings and built-in thermal overload protection. Isolate fan and motor assemblies from unit housing.
3. Evaporator Section: Multiple row, seamless, copper tubing, with aluminum fins mechanically bonded to tubing. Provide coil with two separate refrigerant circuits, each with a thermostatic expansion valve, liquid solenoid valve, liquid line filter drier and moisture indicator. Factory air test coil at 300 psig under water. Provide two insulated drain pans under evaporator coil, each with a threaded drain connection and condensate trap.
 4. Refrigeration Controls: Factory install all refrigeration controls in control panel at unit. Provide motor controller for compressor and condenser fan motors, three leg solid state compressor overload protection, compressor motor winding thermostats, high and low pressure cutouts, oil pressure cutout, non-recycling pump down and reset relay. Cycle guard relay shall protect compressor against cycling, by automatically locking out the system, when operation is interrupted by compressor overload, compressor motor winding thermostat or high pressure cutout. Reset manually at space thermostat.
 5. Options to include (as available, for each unit,) multi speed drive for indoor fan, hail guards, outdoor coil coatings, phase protection, Stainless steel condensate pans and heat exchangers, low ambient kits, dehumidification, Merv-8 filters, hinged access panels, roof curbs, Economizer with enthalpy sensor, CO2 sensor, supply air smoke detector with local restart, (if no fire alarm connection) convenience outlet, fused disconnect, Programmable thermostat and humidistat, (if no display control panel with sensors) flue discharge deflector, and 4 stage heating kit. (By "Modulation Gas Heat, is aftermarket kit.)
- D. Heating Section: Provide a completely factory assembled, integrally piped and wired gas fired heating module, installed in the unit, with components as follows:
1. Heat Exchanger: Free-floating, multi-pass, tubular design, with primary and secondary heat exchanger surfaces, fabricated from heavy gage sheet stainless steel.
 2. Burner: Heavy duty two-stage power burner, modified to 4 stages, with a forced combustion air fan and a stainless burner cone housing the flame sensing rod and spark igniter. Provide fan motor with built-in thermal overload protection.
 3. Induced Draft Fan: Two speed direct driven type, utilizing high speed on high firing and low speed on low fire. Provide fan motor with built-in thermal overload protection.
 4. Combustion Controls: Electronic flame guard controls, requiring the proving of both the induced draft fan and the combustion air fan prior to ignition. Provide a continuous system of electronic flame supervision with the ignition sequence including a 30 second pre-purge, prior to electric ignition of pilot, followed by the energizing of first stage gas valve; a 90 second delay, followed by the opening of the second stage gas valve. Provide FM approved gas train.
- E. Heating Section: Provide a completely factory assembled and wired electric heating system, installed in the unit, with components as follows:

1. Elements: Heavy duty nickel chromium, internally wye connected. Individually fuse element circuits of 48 amps or less.
 2. Control: Stage individual heating elements, through electronic space thermostat, with individual interlock circuits to achieve sequential staging on any start-up condition. Provide each bank of electric heating elements with an automatic reset high limit control operating through heater control contactors. A manual reset high limit control shall provide protection for entire heating system through independent and separate contactors. Design electric heating section for separate power supply, with a factory installed, nonfused disconnect switch.
- F. Heating Section: Provide a factory installed heating coil in the unit, consisting of steam or hot water coils, as indicated on the drawings. All coils shall be of non-ferrous construction with seamless copper tubes mechanically bonded to aluminum fins.
1. Steam Coils: Non-freeze, steam distribution, double tube type, pitched to provide proper drainage.
 2. Water Coils: Pitch to provide for total drainage.
- G. Air Handling Section:
1. Supply Fan: Provide two double inlet, forward curved centrifugal fans mounted on a common shaft, with adjustable drive sheaves and two grease lubricated shaft ball bearings. Isolate entire fan assembly, including motor, from unit frame by means of double deflection rubber-in-shear isolators. Statically and dynamically balance fans at factory.
 2. Filter Section: Provide filter racks integrally mounted within unit, with hinged access doors. Filters shall be of the _____ type in size and number, as noted on the drawings.
 3. Return Air: Provide the following return air system:
 - a. Pressure Relief: Dampers open to relief positive pressure in building. Provide exhaust hood with rain gutter inside unit casing.
 - b. Fan System: Provide multiple double inlet, forward curved centrifugal fans mounted on a common shaft, with adjustable drive sheaves and two grease lubricated ball bearings. Isolate entire fan assembly, including motor, from unit frame with vibration isolators. Statically and dynamically balance fans at factory. Return air system shall include exhaust damper assembly that functions in conjunction with return air dampers. Provide exhaust hood with rain gutter inside unit casing.
 4. Outside Air: Provide the following outside air system:
 - a. Manually controlled damper system for use with a maximum of 25 percent fresh air. (Initial setting 5%.)
 - b. Remote control of return air and outside air up to a maximum of 100 percent fresh air, utilizing motor operated dampers and rheostat. Motors shall be spring return type.
 - c. Economizer Cycle: Provide dampers and controls to provide for the use of outside air for cooling, with control by space thermostat. Controls shall automatically modulate return and outside air dampers, to maintain proper discharge air into conditioned space. Provide an outside air lockout control to

prevent intake of outside air, when outside air temperature is too high. Provide all dampers with spring return feature.

- H. Control Panel: Provide a dual compartment control panel section, as an integral part of the unit. One compartment shall house the refrigeration controls and the other electrical. Electrical control panel shall include a unit-mounted unfused main disconnect switch and 120 volt convenience outlet.
- G. Roof Curbs: Provide factory fabricated roof curbs, designed to be installed in and become an integral part of the roof construction. Curbs shall mate to the air conditioning units required to be installed on same. Curbs shall be the product of the air conditioner manufacturer and shall be approved for use by the National Roofing Contractors Association.
- H. Concentric Supply-Return Diffuser and Connecting Duct: Provide factory fabricated aluminum coiling diffusers and connecting ductwork, designed for use with roof mounted air conditioning units, to provide a concentric supply return through a single roof opening.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Roof Curbs:
 - 1. Install curbs in complete accordance with the manufacturer's printed instructions, and as indicated.
 - 2. Deliver roof curbs to construction contractor for installation.
- B. Air Conditioners:
 - 1. Install air conditioners on roof curbs in complete accordance with the manufacturers' printed instructions, and as indicated.
 - 2. Provide all piping, electrical and ductwork connections to air conditioners through roof curb openings under units.

3.02 FIELD QUALITY CONTROL

- A. Preliminary Requirements: Employ the services of a Company Field Advisor of the rooftop air conditioner manufacturer for the following:
 - 1. Inspect air conditioner installations prior to start-up.
 - 2. Supervise initial start-up of machine.
 - 3. Instruction of State Personnel.
 - 4. Service.
- B. Pre-Start-Up, Start-Up and Instruction: Upon completion of the installation of the air conditioner, to the satisfaction of the Company Field Advisor, start-up and preliminary testing shall be accomplished under the Company Field Advisor's supervision. When all necessary adjustments have been made and air conditioner is properly operating, the Company Field Advisor shall instruct State Personnel in the operation and maintenance of the air conditioner and accessories. Provide

a minimum of 4 hours for instruction purposes exclusive of all pre-start-up and start-up time.

END OF SECTION

SECTION 238239

UNIT HEATERS

PART 1 GENERAL

1.01 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Deliver the following products to the Electric Contractor for installation and connection to power wiring:
 - 1. Line voltage thermostats.
 - 2. Remote mounted speed switches.
- B. Deliver the following products to the Construction Contractor for installation:
 - 1. Outside air intake box assembly including detailed dimensional data.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Vibration Isolation: Section 230550.
- B. Seismic Restraints: Section 230550. (N/A)
- C. Air Filters: Section 234100.
- D. Wiring for Motors and Motor Controllers: Section 260523.
- E. Motors and Motor Controllers: Section 260221.

1.03 PERFORMANCE REQUIREMENTS

- A. Design unit heater and supports to withstand all seismic loads. Refer to seismic loading criteria on the Contract Drawings.
- B. Seismic Performance: Design and install unit heaters to assure continued performance of their intended function when subjected to the specified seismic forces.
- C. Seismic Performance: Design and install unit heaters to assure that they remain in place with no separation of any parts when subjected to the specified seismic forces.
- D. The design of the unit heaters and supports shall be performed by a professional engineer experienced in the seismic design of HVAC equipment.

1.03 SUBMITTALS

- A. Product Data: Catalog cuts, specifications, installation and maintenance instructions for each type of heater specified.

- B. Shop Drawings: Detailed dimensional data for outside air intake box assembly.
- C. Schedule: List manufacturer, unit type, model number, and performance data for each unit heater.
- D. Quality Control Submittals:
 - 1. Copy of Seismic Qualifications Certificate.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Unit heaters shall be UL listed.
- B. Seismic Qualification Certificate: Certificate from unit heater manufacturer covering unit heaters, accessories, supports, and components; and consisting of the following:
 - 1. Basis for Certification: Indicate whether Withstand Certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions, and loads transmitted to structure at each attachment point.
 - 3. Detailed description of equipment anchorage devices on which the certification is based including installation requirements.
 - 4. Comprehensive seismic engineering analysis of unit heaters and supports.

PART 2 PRODUCTS

2.01 PROPELLER TYPE UNIT HEATERS

- A. Unit Casing: Constructed of steel sheet formed, reinforced, and braced for rigidity, with steel louvers or deflectors with sufficient rigidity to prevent vibration at all fan speeds.
 - 1. Materials:
 - a. Galvanized Steel Sheet: ASTM A 653, coating designation G90.
 - b. Cold-Rolled Steel Sheet: ASTM A 366, cleaned, degreased and phosphatized.
 - 2. Factory Finish: Minimum 2 coat baked enamel finish on exposed surfaces, color as directed.
 - 3. Horizontal Delivery Units: Adjustable horizontal and vertical louvers.
 - 4. Vertical Delivery Units: Deflector mounted outside fan orifice.
 - a. Louvered deflector.
 - b. Radial louver deflector.
 - c. Anemostat deflector.
- B. Heating Coils: Mechanically bonded aluminum fins with seamless copper tubing for hot water under 200 psig and steam under 75 psig; and red or admiralty brass tubing for hot water over 200 psig and steam over 75 psig; and factory tested at 300 psig air pressure under water.
- C. Fan Assembly:

1. Fan: Multiple blade propeller type, statically and dynamically balanced, and directly connected to electric motor.
 2. Motor: Single phase, totally enclosed electric motor of the permanent split capacitor or shaded pole type, with resilient mounting, terminal box for wiring connections, built-in overload protection, and ball or sleeve bearings with oilers, or permanently lubricated bearings.
- D. Control: Line voltage thermostat.

2.02 CABINET TYPE UNIT HEATERS

- A. Unit Casing: Constructed of steel sheet formed, reinforced and braced for rigidity, with stamped grilles.
1. Materials:
 - a. Galvanized Steel Sheet: ASTM A 653, coating designation G90.
 - b. Cold-Rolled Steel Sheet: ASTM A 366, cleaned, degreased and phosphatized.
 2. Factory Finish: Minimum 2 coat baked enamel finish on exposed surfaces, color as directed.
 3. Insulation: Insulate interior surfaces of casing panels with 1/2 inch glass fiber meeting NFPA 90A requirements.
 4. Vertical Units: Minimum 18 gage construction with removable front panel.
 5. Horizontal Units: Minimum 18 gage construction with hinged bottom panel.
- B. Heating Coils: Seamless copper tubing with mechanically bonded aluminum fins, designed for 150 psig working pressure for hot water and steam applications, and factory tested at 250 psig air pressure under water.
- C. Fan Assembly: Blow thru design.
1. Fans: Forward curved centrifugal type, double width, statically and dynamically balanced, and directly connected to electric motor.
 2. Motors: Three speed, single phase electric motors of the permanent split capacitor or shaded pole type, with resilient mounting, built-in overload protection with automatic reset, and ball or sleeve bearings with accessible oilers, or permanently lubricated bearings.
- D. Filter Section: Built-in filter frame mounted at air inlet with disposable air filters.
1. Vertical Units: Filters removable without removing front panel for cabinet type units.
 2. Horizontal Units: Filters removed by pivoting hinged bottom panel.
- E. Outside Air Intake Box Assembly: Constructed of coated aluminum with automatic electric operated 25 percent outside air damper, weather resistant louver with insect screen.
- F. Control: Unit mounted line voltage thermostats, and unit mounted speed controller with off position.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install the Work of this section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.

END OF SECTION

SECTION 238240

MINI SPLIT SYSTEMS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Pipe hangers and supports. Section 230529.
- B. Pipe and valve ID: Section 230553.
- C. Cleaning and testing: Section 230593.
- D. Air Filters: Section 234100.
- E. Temperature Control Systems: Section 230923, 230933, or 230943.
- G. Applicable electrical sections of specifications.

1.02 PERFORMANCE REQUIREMENTS

- A. Design air handling unit and supports to withstand all seismic loads. Refer to seismic loading criteria on the Contract Drawings.
- B. Seismic Performance: Design and install air handling units to assure continued performance of their intended function when subjected to the specified seismic forces.
- C. Seismic Performance: Design and install air handling units to assure that they remain in place with no separation of any parts when subjected to the specified seismic forces.
- D. The design of the air handling units and supports shall be performed by a professional engineer experienced in the seismic design of air handling units.

1.02 SUBMITTALS

- A. Shop Drawings: Include on shop drawings all split system units installed under this contract.
- B. Product Data: Manufacturer's catalog sheets, brochures, performance charts, standard schematic drawings, specifications and installation instructions for each size unit

1. Name, address, and telephone number of nearest fully equipped service organization.
- C. Quality Control Submittals:
 1. Copy of Qualifications Certificate.
- D. Contract Closeout Submittals:
 1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Director's Representative
- E. Options
 1. Include in submittals all optional equipment/controls called for in the equipment schedule.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. Unit shall be factory tested and the design, construction and installation shall be in accordance with the following: ARI Standard 210, NFPA, UL, ASHRAE 15, Safety Code for Mechanical Refrigeration, and all State and Local codes or regulations having jurisdiction.
 2. Rate cooling capacities in accordance with ARI Standard 210.
 3. Electrical components shall be UL listed.

1.04 PRODUCT DELIVERY

- A. Deliver each unit as a factory packaged assembly.

1.05 MAINTENANCE

- A. Maintenance Service: A fully equipped authorized service organization capable of guaranteeing response within 8 hours to service calls shall be available 24 hours a day, 7 days a week to service the completed Work. (1 year maintenance and guarantee period.)
- B. Extra Materials: Provide with each unit, one spare set of air filters. Suitable box and label spare filters as to their usage.

PART 2 PRODUCTS

2.01 AIR CONDITIONERS AND/OR HEAT PUMPS

- A. General Design: Provide combination heating and cooling exterior and interior units. Exterior mounted units shall be designed to be exposed to the elements. Units shall consist of a sectional type sheet metal casing, totally enclosing the heating section, evaporator coil and fan section; condenser coil and fan section, and compressor section; all heating, refrigerant and operating controls, totally wired and complete with all internal piping. Upon installation in their permanent locations, connections to service piping, electrical service shall only be required

to put units in operation. Interior units shall be installed as per the contract drawings.

- B. Unit Casings: Fabricate from corrosion resistant sheet steel, properly coated.
- C. Cooling/Hyper heating exterior unit: Factory sealed refrigerant system consisting of compressor, condenser designed for use with Refrigerant R-410.
 - 1. Compressor: Accessible direct driven, variable speed, industrial type, with all required control systems, hail guards, phase protection.
 - 2. Condenser Section: Multiple row, seamless, copper tubing coil, with aluminum fins mechanically bonded to tubing, pressure tested at factory.
 - 3. Refrigeration Controls: Factory install all refrigeration controls in control panel at unit.
 - 5. Options to be included are as stated in equipment schedule.
 - 6. Interior and exterior units as specified in equipment schedule.

PART 3 EXECUTION

3.01 INSTALLATION

- B. All split system components:
 - 1. Provide all piping, electrical, and BMS connections to units.

3.02 FIELD QUALITY CONTROL

- A. Preliminary Requirements: Employ the services of a Company Field Advisor of the chosen manufacturer for the following:
 - 1. Inspect installations prior to start-up.
 - 2. Supervise initial start-up of equipment.
 - 3. Instruction of County Personnel.
 - 4. Service.
- B. Pre-Start-Up, Start-Up and Instruction: Upon completion of the installation of the split systems, to the satisfaction of the Company Field Advisor, start-up and preliminary testing shall be accomplished under the Company Field Advisor's supervision. When all necessary adjustments have been made and split systems are properly operating, the Company Field Advisor shall instruct County Personnel in the operation and maintenance of the split system equipment. Provide a minimum of 4 hours for instruction purposes exclusive of all pre-start-up and start-up time.

END OF SECTION

SECTION 238413
HUMIDIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, Standard General and Supplementary General Conditions, Division 1 Specification Sections, and other applicable Specification Sections including the Related Sections listed below, apply to this Section.
- B. Related Sections:
 - 1. Section 232000: HVAC Piping
 - 2. Section 230523: Valves
 - 3. Section 230553: Mechanical Identification
 - 4. Section 230719: Mechanical Systems Insulation
 - 5. Section 221119: Domestic Water Piping Specialties
 - 6. Division 26: Electrical

1.2 SUMMARY

- A. Products specified in this section include the following:
 - 1. Jacketed Steam Humidifiers
 - 2. Steam Injection Dispersion Panels
 - 3. Self-contained Electric Humidifiers
 - 4. Condensate Drain Coolers

1.3 SUBMITTALS

- A. Product Data: Include catalog illustrations, model, rated capacities, performance, weights, dimensions, component sizes, rough-in requirements, piping and wiring diagrams and details, materials of construction, accessories, operating and maintenance clearance requirements. Wiring diagrams shall be project specific, and differentiate between factory wiring and field wiring. Include shop drawings and fabrication drawings for equipment indicating piping connections, power and utility requirements, rigging, installation and support details and instructions. Include written sequence of operations for all controls, BMS compatibility.
- B. Provide information for the following:
 - 1. At conditions specific to the project:
 - a. Non-wetting (absorption) distance, assuming air downstream of the humidifier is 90% R.H. at 52°F
 - b. Air pressure drop across the humidifier array
 - c. For steam injection dispersion panels, required orientation of tubes in the duct.
 - 2. Strainers and steam traps
 - 3. Humidifier actuator and temperature switch
 - 4. Room and duct transmitters and proof of air flow switch
 - 5. Electrode type self-contained Electric humidifiers:
 - a. Published cylinder life based on incoming water conductivity
 - b. Published replacement pricing
 - 6. Condensate drain cooler. (If not integral to the unit.)
 - 7. Installation, operation, and maintenance manuals

1.4 QUALITY ASSURANCE

- A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.
- B. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions, unless noted otherwise.
 - 1. Underwriters Laboratories

1.5 DELIVERY, STORAGE AND HANDLING

- A. Ship all components in weather-proof wrap for storage outdoors. Protect control panels, pipe openings, and other sensitive components with heavy plastic or other durable means to ensure cleanliness and prevent damage during shipping and storage. Maintain protection during installation.

1.6 WARRANTY

- A. Provide a complete warranty for parts and labor for a minimum of one year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Basis of Design and model numbers (where provided) are Dri-Steem. Subject to compliance with all requirements and matching the features of the Basis of Design and model numbers, provide products from any of the below manufacturers.
 - 1. Armstrong
 - 2. Carel
 - 3. Dri-Steem
 - 4. Approved submitted substitute

2.2 JACKETED STEAM HUMIDIFIERS

- A. Steam separator type that discharges dry steam into the air stream through a steam jacketed dispersion tube or manifolded dispersion tubes. Humidifiers shall be complete with Y-type steam supply strainer, modulating steam control valve, condensate temperature switch and steam traps; all provided by the humidifier manufacturer. Provide manifolded multiple dispersion tube type when required to meet the capacity requirements or the conditions at the mounting location, including the indicated non-wetting (absorption) distance. All components shall be rated for a minimum 100 PSIG steam working pressure.
- B. The humidifier shall provide absorption characteristics that preclude wetting on any in-duct surfaces within the indicated absorption distance downstream of the humidifier while maintaining conditions of 90% (maximum) relative humidity at a minimum temperature of 52°F in the duct air stream.
- C. Unless indicated otherwise, the air pressure loss across the humidifier array shall not exceed 0.10" W.C. at a duct air velocity of 1200 FPM.
- D. Provide type 304 stainless steel dispersion tubes, manifold and separator.

- E. Dispersion tubes shall be surrounded by a steam jacket and shall span the width of duct.
- F. Provide bronze or stainless steel, fail closed, steam control valve for operation with a modulating 3-15 PSI control air signal, minimum 13:1 rangeability and ANSI Class 5 Shutoff.
- G. Provide a condensate temperature switch for interlocking with control valve. Switch shall be normally closed and shall prevent steam flow to dispersion tubes upon cold start or flooded condensate line.
- H. Steam traps shall be per Related Section, sized and provided by the humidifier manufacturer. Provide F & T or thermostatic traps that allow modulating steam control valve service.
- I. Provide Type 316 stainless steel dispersion tubes, manifold, separator, and interconnecting piping; and stainless steel strainers, control valve and traps when fed by clean steam (steam generated with RO/DI water).
- J. Dispersion tubes shall be insulated with 1/2" fiberglass, enclosed in a stainless steel wrapper.

2.3 STEAM INJECTION DISPENSER

A. Ultra-sorb LV/HV Multi-tube style - TYPE A:

1. Multi-tube non-jacketed style humidifier for use with pressurized or non-pressurized steam and gravity draining of condensate. Each panel shall consist of a steam supply header/separator, a condensate collection header and a bank of closely spaced steam dispersion tubes spanning the distance between the two headers. Stainless steel construction. Humidifiers shall be complete with Y-type steam supply strainer, modulating steam control valve, condensate temperature switch and steam traps; all provided by the humidifier manufacturer. All components shall be rated for a minimum 100 PSIG steam working pressure.
2. Each steam tube outlet shall contain an orifice sized for its required steam capacity. The humidifier shall provide absorption characteristics that preclude wetting on any in-duct surfaces within the indicated absorption distance downstream of the humidifier while maintaining conditions of 90% (maximum) relative humidity at a minimum temperature of 52°F in the duct air stream.
3. Unless indicated otherwise, the air pressure loss across the humidifier array shall not exceed 0.10" W.C. at a duct air velocity of 1200 FPM.
4. Provide horizontally or vertically oriented tubes as required for the specific location, considering the steam pressure available at that location.
5. Each packaged humidifier panel assembly of tubes and headers shall be contained within a galvanized metal casing to allow convenient duct mounting or to facilitate the stacking of and/or the end-to-end mounting of multiple panels in ducts or air handler casings. Provide multiple panels and all related accessories for the panels and installation, in order to achieve the specified capacities.
6. Provide type 304 stainless steel tubes and headers. All joints shall be heli-arc welded.
7. Provide bronze or stainless steel, fail closed, steam control valve for operation with a modulating 3-15 PSI control air signal, minimum 13:1 rangeability and ANSI Class 5 Shutoff.

8. Provide Type 316 stainless steel humidifier construction and stainless steel strainer and control valve when fed by clean steam (steam generated with RO/DI water).
9. High-efficiency insulated tubes shall be used to substantially reduce dispersion-generated condensate and airstream heat gain. Tube insulation shall be 1/8" thick polyvinylidene fluoride insulation (PVDF).

B. Ultra-sorb XV Multi-tube Style - TYPE B:

1. Multi-tube non-jacketed style humidifier for use with pressurized steam, with integral heat exchanger to provide for condensate lifting. Each panel shall consist of a steam supply header/separator, a condensate collection header and a bank of closely spaced steam dispersion tubes spanning the distance between the two headers. Stainless steel construction. Humidifiers shall be complete with Y-type steam supply strainer, modulating steam control valve, condensate temperature switch and steam traps; all provided by the humidifier manufacturer.
2. Each steam tube outlet shall contain an orifice sized for its required steam capacity. The humidifier shall provide absorption characteristics that preclude wetting on any in-duct surfaces within the indicated absorption distance downstream of the humidifier while maintaining conditions of 90% (maximum) relative humidity at a minimum temperature of 52°F in the duct air stream
3. Unless indicated otherwise, air pressure loss across humidifier panel shall not exceed 0.10" W.C. at a duct air velocity of 1200 FPM.
4. Provide horizontally or vertically oriented tubes as required for the specific location, considering available steam pressure at that location.
5. Each packaged humidifier panel assembly of tubes and headers shall be contained within a galvanized metal casing to allow convenient duct mounting or to facilitate the stacking of and/or the end-to-end mounting of multiple panels in ducts or air handler casings. Provide multiple panels and all related accessories for the panels and installation, in order to achieve the specified capacities.
6. Provide type 304 stainless steel tubes and headers. All joints shall be heli-arc welded.
7. Provide bronze or stainless steel, fail closed, steam control valve for operation with a modulating control air signal, minimum 10:1 rangeability and ANSI Class 5 Shutoff.

8. Provide a condensate temperature switch for interlocking with control valve. Switch shall be normally closed and shall prevent steam flow to dispersion tubes upon cold start or flooded condensate line.
9. Provide an integral steam heat exchanger with steam trap arranged to vaporize dispersion-tube-generated steam condensate and return pressurized condensate to a condensate return main.
10. High-efficiency insulated tubes shall be used to substantially reduce dispersion-generated condensate and airstream heat gain. Tube insulation shall be 1/8" thick polyvinylidene fluoride insulation (PVDF).

2.4 SELF-CONTAINED ELECTRIC HUMIDIFIERS

- A. Packaged wall mounted self-contained U.L. listed electric humidification unit providing all required steam generation equipment and controls, to provide atmospheric pressure steam generation. Provide either Steam Injection Distribution Panels for steam injection into ducts, or Blower Pack for direct space applications, as indicated.
- B. Furnish electrode heating element type humidifier capable of boiling water at the required capacity with a minimum conductivity of 125 umho (micro-mho).
 1. Replaceable plastic steam cylinder.
 2. Controller shall monitor water conductivity and automatically drain and flush unit to reduce solids build-up and optimize humidifier performance.
 3. Published cylinder life based on incoming water conductivity.

4. Published replacement pricing.
 5. Pre-notification of automatic shutdown at end of cylinder life
 6. Power to the heating elements shall be controlled through the actuation of contactors and solid state relays, to provide a control accuracy of +/- 5% RH or better.
- C. Furnish resistance heating element type humidifier capable of boiling water at the required capacity using tap water.
1. Serviceable stainless steel steam cylinder.
 2. Controller shall automatically drain and flush unit to reduce solids build-up and optimize humidifier performance.
 3. Corrosion resistant heating elements.
 4. Water level control shall be provided by float switch or float valve located in a portion of the tank segregated from the main steam generating portion of the tank.
 5. Power to the heating elements shall be controlled through the actuation of contactors and solid state relays, to provide a control accuracy of +/- 3% RH or better.
- D. Over temperature safety switch to prevent heating element failure.
- E. Water make-up system with inlet strainer, solenoid valve with flow regulator, and fill tee or cup with built-in air gap to prevent back siphoning
- F. Solenoid operated automatic drain valve.
- G. Bottom drain outlet. Large perforated strainer at drain outlet to prevent blockage of drain valve or drain lines
- H. A system on/off switch with power indicator light, external to the humidifier enclosure.
- I. Enclosure to be minimum 18 gauge steel and powder-coat painted to prevent against corrosion. The electrical and steam generating compartments shall be separate, but contained within the same cabinet to minimize field wiring. The cylinder access door shall be lockable with a key. A door interlock switch shall prevent humidifier operation when the access door is open.
- J. Provide a fan blower pack to disperse steam directly into the room air. Blower pack shall be 120 VAC and shall be capable of being mounted integral to the top of the humidification unit, or remotely via interconnecting piping. Provide an air flow proving switch to prevent humidification when the blower fan is off. **(N/A)**
- K. Controls
1. Provide a UL listed and labeled microcomputer based controller with the following capabilities:

- a. Control of humidity to within +/- 3% RH (resistance heating element type humidifiers) or +/- 5% RH of set point (electrode heating element type humidifiers).
 - b. Proportional/integral/derivative (PID) algorithms for humidifier control.
 - c. Integral 24 VDC power supply of adequate size to power controllers and all axillary devices (humidity transmitters, etc.)
 - d. LCD or LED display and integral controller keypad to allow adjustment of all humidifier settings, programming of alarms and viewing of alarm history.
 - e. High water sensor circuitry to prevent over filling.
 - f. Integral drain water tempering feature. Drain water shall be automatically cooled to below 140°F before entering the drain.
 - 1) If unit cannot provide this feature, provide an external condensate drain cooler.
 - g. Automatic drain and flush feature to reduce the concentration of conductive ions in the water and reduce mineral build-up.
 - h. Automatic off-season shut-down [user adjustable, factory default set after 3 days of "no call"] to completely drain the tank(s) and automatically restart unit on call for humidity.
 - i. External fan control: controller shall have the ability to cycle an external steam dispersion fan on and off in conjunction with a call for humidification.
 - j. Fan control off-delay feature. When the humidifier unit controls an external fan, fan "off" is time delayed after steam output stops.
 - k. A dry contact rated 10 amps at 24 VDC, which can be programmed to energize when any humidifier alarm condition occurs.
 - l. Password protection. Controller adjustment shall only be enabled after a password is entered. It shall be possible to disable the password protection feature.
 - m. For duct mounted humidifiers, controller shall limit duct humidity downstream of the humidifier to a user adjustable set point by modulating humidifier output, and prevent humidifier operation if duct air flow is not present.
 - n. For space mounted humidifiers, controller shall prevent humidifier operation if air flow is not present at the blower fan.
 - o. The controller shall monitor and display the following conditions, minimum:
 - 1) Space relative humidity
 - 2) Space relative humidity set point
 - 3) Space dew point
 - 4) Space dew point set point
 - 5) Duct relative humidity
 - 6) Duct high relative humidity limit set point
 - 7) Air flow status
 - 8) Tank temperature
 - 9) Tank level
 - 10) All units shall be displayed in inch-pounds.
2. Controller shall accept two wire 4-20mA input signals for space humidity, duct humidity, and room temperature.

3. Provide the following auxiliary devices for use with the humidifier controller:
 - a. 4-20 mA room humidity transmitter
 - b. 4-20 mA duct relative humidity transmitter (duct mounted humidifiers only)
 - c. Air flow proving switch
 - d. Auxiliary devices shall comply with Related Section Mechanical Systems Control, and be compatible with the humidifier controller.
4. Controller shall be capable of operation in ambient conditions of 32°F to 140°F and a humidity range of 5% to 95%, non-condensing.
5. The controller shall hold its software in non-volatile memory. On-line field modified data entries shall be stored in flash memory to prevent accidental loss of data due to power loss, voltage surge or spike. In the event of a complete power outage, all field and factory settings shall remain stored and shall automatically be restored when power is restored
6. If available as an option for the humidifier, please provide humidifier set point reset based on window glass temperature, to prevent condensation on windows. Provide control algorithm and 4-20 mA temperature transmitter with a RTD designed to be mounted on a window surface.
7. Manufacturer of selected humidifier system to provide information relative to the above.

2.5 CONDENSATE DRAIN COOLER (If not provided with unit)

- A. Provide a stainless steel drain cooler for condensate water being discharged. Provide a unit of size and volume adequate for handling the expected discharge from the humidification system.
- B. Drain cooler shall include a self-actuated thermostatically controlled water valve to control mixing.
- C. Drain cooler shall be capable of metering a sufficient amount of cold water into the mixing chamber to temper 212°F (100°C) water to a 140°F (60°C) max. discharge temperature
- D. Cooler dimensions must allow gravity flow of condensate to the waste discharge point based on the height of the humidifier's condensate discharge connection.
- E. Provide all mounting components and hardware required to properly support the drain cooler, independent of the humidifier unit.
- F. Provide a vacuum breaker in the unit to prevent backflow into the potable water systems.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Store units protected from weather, dirt, water, and construction debris.

- B. Examine roughing-in for equipment support, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting equipment performance, maintenance, and operations. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install in strict compliance with manufacturer's installation instructions and Related Sections. Maintain manufacturer's recommended clearances for service and maintenance.
- B. Route steam line to humidifier by connecting to top of steam main either straight up, 45 degrees, or . If required, provide a steam trap upstream of the humidifier if the top of steam main could not be tapped or if the distance between the steam main and the humidifier exceeds ten feet.
- C. Install separate devices furnished by manufacturer and not factory installed, including but not limited to control valve, steam traps, and temperature switch.
- D. Provide and install any manufacturer's accessory devices necessary or recommended to meet the particular needs of the humidifier installation.
- E. Install condensate drain coolers where indicated or required.
- F. Install to provide a minimum of ten feet of straight, unobstructed (no filters, turning vanes, etc.) duct downstream from the humidifier, unless a shorter non-wetting (absorption) distance upstream of such obstructions is indicated on the reviewed/approved submittal.
- G. Direction of steam injection relative to air flow is dependent on humidifier features and duct orientation. Review manufacturer's installation instructions carefully and install accordingly.
- H. Seal all duct penetrations made as a result of humidifier installation. Use sealant appropriate for service.
- I. Jacketed Steam Humidifiers
 - 1. Install the humidifier's discharge steam trap to allow the condensate piping to drain by gravity. Do not lift condensate piping downstream of this steam trap.
- J. Steam Injection Dispersion Panels
 - 1. Dispersion panels are typically designed for a specific duct orientation (either horizontal or vertically oriented duct). Verify that the dispersion panel supplied is the correct model for the duct orientation at the humidifier mounting location.
 - 2. Rotate tubes to the correct orientation to inject steam into the air stream, typically perpendicular to the air stream.
 - 3. Install all required p-traps. Do not lift condensate discharging from p-traps

K. Self-Contained Electric Humidifiers

1. Mount humidifier and accessories at locations indicated on the drawings, maintaining manufacturers recommended service clearances.
2. Connect power to the humidifier. Comply with Division 26 requirements.
3. Install water supply and drain piping to each unit in compliance with manufacturer's recommendations, including pipe sizes.
 - a. Install an isolation valve, water hammer arrestor, and a strainer in the supply piping to the humidifier. Install the strainer between the isolation valve and the humidifier.
 - b. When plastic pipe is used for water supply piping, provide a minimum of 3 feet of stainless steel tubing for the last 3 feet of the supply piping before connecting to the unit.
 - c. Install unions at each supply and drain connection.
 - d. Install traps in supply and drain piping as recommended by the unit manufacturer.
 - e. All drain piping shall be type L copper pipe. When humidifiers are not installed in mechanical rooms or similar spaces that are typically inaccessible to occupants, insulate the tank/flush drain with ½" thick insulation per Related Section. Overflow drains do not require insulation.
4. Connect drain piping via an air gap fitting to the building drain. Prior to connecting to building drain, install a condensate drain cooler for units that are not equipped with an integral drain water tempering feature.
5. Install steam vapor hose or piping, as indicated, between steam dispersion device and humidifier.
 - a. Piping material shall be per Related Section.
 - b. When piping is used, install a union at the humidifier to allow humidifier removal.
 - c. Electrically ground the piping. Bond the ground to the humidifier cabinet ground.
 - d. When hose is used, use approved hose, fittings, and clamps obtained from the humidifier manufacturer.
 - e. Pitch steam vapor hose or piping to allow condensate to drain back into the humidifier.
 - f. Install steam condensate drains where required. Route such drains back to the humidifier tank fill connection in lieu of to a building drain where possible and when permitted by humidifier manufacturer.

- 1) Where routed to building drains, provide condensate cooler (if not provided as part of the unit) and route drain through cooler before connection to building drain.
- g. Insulate hose/piping per Related Section.
6. Install steam dispersion devices.
7. Install the fan blower pack when (if) utilized.
 - a. Mount blower pack to prevent the discharged steam from condensing on nearby surfaces.
 - b. Install power to blower pack in compliance with Division 26 requirements.
 - c. When mounted remote from the humidifier, install steam vapor hose or piping between humidifier and blower pack, pitched to allow condensate to drain back to humidifier. Install drain piping, complying with the same requirements indicated above for the humidifier drain piping.
8. Install separate devices furnished by manufacturer and not factory installed, including but not limited to, room humidity transmitter, proof of air flow switch, duct high limit humidity transmitter, and control wiring between fan blower pack and humidifier.
 - a. Install wiring in conformance with Related Section (Mechanical Systems Controls), utilizing approved contractors listed in that section.
9. Program the humidifier controller.

3.3 STARTUP

- A. Adhere to manufacturer's start-up instructions.
- B. Assure that actuators operate freely, close off steam tightly (no leaking steam discharges into the duct or space), and that the stem packing is not leaking. Verify proper steam trap operation.
- C. For dispersion panel types, check dispersion tubes for leaks at slip couplings while steam is being injected into the duct or space; repair any leaks.
- D. When provided as part of the humidifier package, verify that the air flow proving switch and duct high limit humidistat operate properly. Prime any p-traps and verify the operation of temperature switches, float switches, and similar devices specified or provided, prior to putting humidifier into operation.
- E. For self-contained electric humidifiers, adjust all control parameters as directed by the Commissioner and as appropriate for the project, and place into service. For projects without a Commissioner, consult the project engineer for direction regarding control parameter settings. Record all settings and include in the O&M manual.

3.4 COMMISSIONING

- A. Perform Commissioning activities per Related Sections above.
- B. Commissioning to be done by factory approved/certified representative.

3.5 TRAINING

- A. Provide a qualified certified service technician from the Manufacturer's staff to provide training.
- B. Train Owner's maintenance personnel on equipment operation, start-up and shutdown, trouble-shooting, servicing and preventative maintenance procedures. Review the data contained in the Operating and Maintenance Manuals with Owner's personnel. Training shall occur separate from startup activities.
 - 1. Provide 2 hours of training minimum.

END OF SECTION 238413

BuildingName
The Description of the Project

SECTION 260010
GENERAL PROVISIONS FOR ELECTRICAL WORK

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Provide labor, materials, tools, machinery, equipment, and services necessary to complete the Electrical Work under this Contract. All systems and equipment shall be complete in every aspect and all items of material, equipment and labor shall be provided for a fully operational system and ready for use. Coordinate the work with the work of the other trades in order to resolve all conflicts without impeding the job progress. Contractor shall provide any service, material or equipment not specifically mentioned in these specifications or set forth in the drawings but required to complete this Project without requesting any additional time to complete the Project and without additional cost to Nassau County Department of Public Works.
- B. When an item of equipment is indicated on a floor plan and not shown on associated riser diagram or vice-versa, the Contractor shall provide said item and all required conduit and wiring connections for a complete system as part of the Contract.
- C. Examine the Structural, Plumbing and Electrical Drawings and other Divisions, and Sections of the Specifications in order to determine the extent of the Work required to be completed under this Division. Failure to examine all the Contract Documents for this Project will not relieve this Section and any other Sections of their responsibilities to perform the Work required for a complete fully operational and satisfactory installation.
- D. Contractor shall comply with all laws, regulations, rules, orders, codes, requirements, and the like of federal, state and local governments, courts, governmental authorities, legislative bodies, boards, agencies, commissions and the like (“Laws”). If there is a conflict between or among any Laws and specific requirements of this Contract, then Contractor shall comply with the most stringent Law or requirement in each instance. By noting any specific Law(s) with particularity in this Contract or in any other prior or future communication, Contractor is not relieved of any obligation to comply with all Laws and the Owner does not waive any rights it may have with respect to such compliance.
- E. Provide and pay for all materials, labor, services, equipment, licenses, taxes and other items necessary for the execution, installation and completion of Work indicated in Contract Documents.
- F. Start-up services shall be included in the bid.
- G. All systems, equipment and services specified herein shall be provided complete and ready for use.

1.02 EXAMINATION OF SITE

- A. The Contractor shall be held to have examined the site and to have compared it with the Drawings and Specifications, and deemed to have been satisfied as to the conditions existing at the site, as relating to the actual conditions of the site at the time estimating the Work, the storage and handling of materials, and all other matters as may be incidental to the Work under the Contract, before bidding, and no allowance will subsequently be made to the Contractor by reason of any error due to the Contractor's neglect to comply with the requirements of this clause.
- B. Verify final locations for rough work with field measurements and with the requirements of the actual equipment being connected.

1.03 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract.
- B. Division 1 – General and Supplementary Requirements.

1.04 ELECTRICAL EQUIPMENT

- A. All electrical equipment shall be the latest of the current year in design, material and workmanship, and shall be the type or model called for in these Specifications.
- B. If the type or model specified has been superseded by a later type or model, the latest shall be submitted for approval and shall be provided as part of the Contract.

1.05 SUBMITTALS

Provide as outlined in each individual section of these Specifications, including but not limited to:

- A. Product Data: Submit manufacturer's product data for equipment including capacity, performance charts, test data, materials, dimensions, weights, and installation instructions.
- B. Shop Drawings: Submit manufacture's shop drawings indicating dimensions, weight loading, required clearances, location, and method of assembly of components.

Submittals are mandatory as noted in the respective specifications. Schedules, installation instructions, startup manuals, operation and maintenance manuals, and shop drawings are always required to be submitted.

- C. Samples.
- D. Special Warranty.
- E. Quality Assurance Submittals.
- F. Operation and Maintenance Manuals.

- G. Test Results and Certificates.

1.06 COORDINATION DRAWINGS

- A. Provide coordination drawings. Coordination drawings shall be completed so as not to delay the progress of the Project.

1.07 CODE COMPLIANCE

- A. Drawings and Specifications:
1. It is the intent of these Specifications that all electric work shall be done in strict accordance with the rules of the local Authority Having Jurisdiction (AHJ), local Utility requirements and with the latest applicable version of the NFPA National Electrical Code. Where the requirement of the Drawings or Specifications exceeds the requirements of the Electrical Code, the requirements of the Drawings and Specifications shall be binding upon the Contractor.
 2. Should the AHJ inspect the work and issue a violation, the Contractor shall correct the Work and eliminate the violation as part of the Contract.
- B. Interpretation
1. The electric work detailed in these Specifications and shown on Drawings shall be under the jurisdiction of the Owner, subject to the approval of the AHJ.
 2. The Owner shall be the sole source for interpretation of the Contract Documents. Any discrepancies or conflicts shall be brought to the attention of the Owner for clarification.
- C. Materials and Appliance: All materials and appliance shall be approved by the Owner's Representative and installed in accordance with the rules and regulations of the local Building Department, AHJ; certificates of approval including the temporary light and power wiring, shall be obtained by the Contractor and delivered to the Owner's Representative before the Work is finally accepted.

1.08 ELECTRICAL INSTALLATIONS

- A. Coordinate Electrical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings to allow for Electrical installations.
- D. Sequence, coordinate, and integrate installations of Electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning and entrance prior to the close of the building.

- E. Provide a coordinated set of drawings for the project, verifying the integration of the installation clearances between the new components and the existing, and submit for approval prior to initiating construction.
- F. Coordinate the cutting and patching of building components to accommodate the installation of Electrical equipment and materials.
- G. Where mounting heights are not detailed or dimensioned, install Electrical services and overhead equipment to provide the maximum headroom possible.
- H. Install Electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting and minimum of interference with other installations.
- I. Coordinate the installation of Electrical materials and equipment above ceilings with suspension system, light fixtures, and all other installations and accessories.

1.09 TESTS

- A. The Contractor shall demonstrate to the Owner operation of all equipment and systems. All tests shall be completed to the satisfaction of the Owner. Each test shall be performed as indicated in the individual specification section.

1.10 GUARANTEES, WARRANTIES, BONDS, AND MAINTENANCE CONTROL

- A. Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.
 - 1. Compile and assemble the warranties specified for Electrical work into a separated set of documents, tabulated and indexed for easy reference.
 - 2. Provide complete warranty information for each item to include product or equipment including duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.
 - 3. Warranties for the equipment, workmanship and materials should be provided for the period of one year.
 - 4. Manufacturers', in addition to Contractors' warranties, shall be provided for all Electrical equipment and accessories.
 - 5. All warranties are to start from the date of Substantial Completion.

1.12 CLEANING AND REPAIR

- A. On completion of installation, inspect interior and exterior of installed equipment. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

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- B. Contractor shall not leave sharp exposed metal edges (bottom of threaded rods, electrical equipment supports, etc.) that could otherwise present safety hazards to the building's occupants/work staff.

LIST OF SUBMITTALS

<u>SUBMITTAL</u>	<u>DATE SUBMITTED</u>	<u>DATE APPROVED</u>
Product Data	_____	_____
Shop Drawings	_____	_____

END OF SECTION

* * *

SECTION 260519

WIRING, GENERAL

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.

1.02 PRODUCT DELIVERY

- A. Mark and tag insulated conductors and cables for delivery to the site. Include:
1. Contractor's name.
 2. Project title and number.
 3. Date of manufacture (month & year).
 4. Manufacturer's name.
 5. Data which explains the meaning of coded identification (UL assigned electrical reference numbers, UL assigned combination of color marker threads, etc.).
 6. Environmental suitability information (listed or marked "sunlight resistant" where exposed to direct rays of sun; wet locations listed/marked for use in wet locations; other applications listed/marked suitable for the applications).

PART 2 PRODUCTS

2.01 INSULATED CONDUCTORS AND CABLES

- A. Date of Manufacture: No insulated conductor more than one year old when delivered to the site will be acceptable.
- B. Acceptable Companies: American Insulated Wire Corp., BICC General Cable Industries Inc., Cerro Wire & Cable Co. Inc., Pirelli Cable Corp., or Southwire Co.
- C. Conductors: Annealed uncoated copper or annealed coated copper in conformance with the applicable standards for the type of insulation to be applied on the conductor. Conductor sizes No. 8 and larger shall be stranded.
- D. Types:
1. Electric Light and Power Wiring:
 - a. General: Rated 600V, NFPA 70 Type FEP, THHN, THW, THW-2, THWN, THWN-2, XHH, XHHW, XHHW-2.
 - b. THWN Gasoline and Oil Resistant: Polyvinylchloride insulation rated 600 V with nylon jacket conforming to UL requirements for type THWN insulation, with the words "GASOLINE AND OIL RESISTANT II" marked thereon.
 - c. I: AFC Cable Systems' Type MI Cable, or BICC/Pyrotenax Mineral

Insulated System 1850 Pyrotenax Cable:

- 1) Copper conductors.
- 2) Seamless copper sheath.
- 3) Two hour fire resistive rating UL system classified, listed in UL Building Materials Directory product category Electrical circuit Protective Systems (FHIT), or Fire Resistive Cables (FHJR).
- 4) PVC or HDPE jacketing (where shown on drawings).
- 5) 600 volt rating.
- 6) Fittings and accessories as required for a complete system to suit listing and installation conditions.

2.02 CONNECTORS

A. General:

1. Connectors specified are part of a system. Furnish connectors and components, and use specific tools and methods as recommended by connector manufacturer to form complete connector system.
2. Connectors shall be UL 486 A listed, or UL 486 B listed for combination dual rated copper/aluminum connectors (marked AL7CU for 75 degrees C rated circuits and AL9CU for 90 degrees C rated circuits).

B. Splices:

1. Spring Type:
 - a. Rated 105° C, 600V; Buchanan/Ideal Industries Inc.'s B-Cap, Electrical Products Div./3M's Scotchlok Type Y, R, G, B, O/B+, R/Y+, or B/G+, or Ideal Industries Inc.'s Wing Nuts or Wire Nuts.
 - b. Rated 150° C, 600V; Ideal Industries Inc.'s High Temperature Wire-Nut Model 73B, 59B.
2. Indent Type with Insulating Jacket:
 - a. Rated 105° C, 600V; Buchanan/Ideal Industries Inc.'s Crimp Connectors, Ideal Industries Inc.'s Crimp Connectors, Penn-Union Corp.'s Penn-Crimps, or Thomas & Betts Corp.'s STA-KON.
3. Indent Type (Uninsulated): Anderson/Hubbell's Versa-Crimp, VERSAtile, Blackburn/T&B Corp.'s Color-Coded Compression Connectors, Electrical Products Div./3M's Scotchlok 10000, 11000 Series, Framatome Connectors/Burndy's Hydent, Penn-Union Corp.'s BCU, BBCU Series, or Thomas & Betts Corp.'s Compression Connectors.
4. Connector Blocks: NIS Industires Inc.'s Polaris System, or Thomas & Betts Corp.'s Blackburn AMT Series.
5. Resin Splice Kits: Electrical Products Div./3M's Scotchcast Brand Kit Nos. 82A Series, 82-B1 or 90-B1, or Scotchcast Brand Resin Pressure Splicing Method.
6. Heat Shrinkable Splices: Electrical Products Div./3M's ITCN, Raychem Corp.'s Thermofit Type WCS, or Thomas & Betts Corp.'s SHRINK-KON Insulators.
7. Cold Shrink Splices: Electrical Products Div./3M's 8420 Series.

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8. All splices shall be made in adequately sized junction box per the National Electric code.
- C. Gutter Taps: Anderson/Hubbell's GP/GT with GTC Series Covers, Blackburn/T&B Corp.'s H-Tap Type CF with Type C Covers, Framatome Connectors/Burndy's Polytap KPU-AC, H-Crimpit Type YH with CF-FR Series Covers, ILSCO's GTA Series with GTC Series Covers, Ideal Industries Inc.'s Power-Connect GP, GT Series with GIC covers, NSI Industries Inc.'s Polaris System, OZ/Gedney Co.'s PMX or PT with PMXC, PTC Covers, Penn-Union Corp.'s CDT Series, or Thomas & Betts Corp.'s Color-Keyed H Tap CHT with HTC Covers.
- D. Terminals: Nylon insulated pressure terminal connectors by Amp-Tyco/Electronics, Electrical Products Div./3M, Framatome Connectors/Burndy, Ideal Industries Inc., Panduit Corp., Penn-Union Corp., Thomas & Betts Corp., or Wiremold Co.
- E. Lugs:
 1. Single Cable (Compression Type Lugs): Copper, one or 2 hole style (to suit conditions), long barrel; Anderson/Hubbell's VERSAtile VHCL, Blackburn/T&B Corp.'s Color-Coded CTL, LCN, Framatome Connectors/Burndy's Hylug YA, Electrical Products Div./3M Scotchlok 31036 or 31145 Series, Ideal Industries Inc.'s CCB or CCBL, NSI Industries Inc.'s L, LN Series, Penn-Union Corp.'s BBLU Series, or Thomas & Betts Corp.'s 54930BE or 54850BE Series.
 2. Single Cable (Mechanical Type Lugs): Copper, one or 2 hole style (to suit conditions); Blackburn/T&B Corp.'s Color-Keyed Locktite Series, Framatome Connectors/Burndy's Qiklug Series, NSI Industries Inc.'s Type TL, Penn-Union Corp.'s VI-TITE Terminal Lug Series, or Thomas & Betts Corp.'s Locktite Series.
 3. Multiple Cable (Mechanical Type Lugs): Copper, configuration to suit conditions; Framatome Connectors/Burndy's Qiklug Series, NSI Industries Inc.'s Type TL, Penn-Union Corp.'s VI-TITE Terminal Lug Series, or Thomas & Betts Corp.'s Color-Keyed Locktite Series.

2.03 TAPES

- A. Insulation Tapes:
 1. Plastic Tape: Electrical Products Div./3M's Scotch Super 33+ or Scotch 88, Plymouth Rubber Co.'s Plymouth/ Bishop Premium 85CW.
 2. Rubber Tape: Electrical Products Div./3M's Scotch 130C, or Plymouth Rubber Co.'s Plymouth/Bishop W963 Plysafe.
- B. Moisture Sealing Tape: Electrical Products Div./3M's Scotch 2200 or 2210, or Plymouth Rubber Co.'s Plymouth/Bishop 4000 Plyseal-V.
- C. Electrical Filler Tape: Electrical Products Div./3M's Scotchfil, or Plymouth Rubber Co.'s Plymouth/Bishop 125 Electrical Filler Tape.
- D. Color Coding Tape: Electrical Products Div./3M's Scotch 35, or Plymouth Rubber Co.'s Plymouth/Bishop Premium 37 Color Coding.

2.04 WIRE-PULLING COMPOUNDS

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- A. To suit type of insulation; American Polywater Corp.'s Polywater Series, Electric Products Div./3M's WL, WLX, or WLW, Greenlee Textron Inc.'s Y-ER-EAS, Cable Cream, Cable Gel, Winter Gel, Ideal Industries Inc.'s Yellow 77, Aqua-Gel II, Agua-Gel CW, or Thomas & Betts Corp.'s Series 15-230 Cable Pulling Lubricants, or Series 15-631 Wire Slick.

2.05 TAGS

- A. Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inches high.
 - 1. Phenolic: Two color laminated engraver's stock, 1/16 inch minimum thickness, machine engraved to expose inner core color (white).
 - 2. Aluminum: Standard aluminum alloy plate stock, minimum .032 inches thick, engraved areas enamel filled or background enameled with natural aluminum engraved characters.

2.06 WIRE MANAGEMENT PRODUCTS

- A. Cable Clamps and Clips, Cable Ties, Spiral Wraps, etc: Catamount/T&B Corp., or Ideal Industries Inc.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install conductors in raceways after the raceway system is completed. Exceptions: Type MI, or other type specifically indicated on the drawings not to be installed in raceways.
- B. No grease, oil, or lubricant other than wire-pulling compounds specified may be used to facilitate the installation of conductors.

3.02 CIRCUITING

- A. Do not change, group or combine circuits other than as indicated on the drawings.
- B. Do not change, group or combine circuits other than as indicated on the drawings except as permitted under Section 260532 when reusing existing raceways.

3.03 COMMON NEUTRAL CONDUCTOR

- A. A common neutral may be used for 2 or 3 branch circuits where the circuits are indicated on the drawings to be enclosed within the same raceway, provided each branch circuit is connected to different phase busses in the panelboard.
- B. Exceptions - The following circuits shall have a separate neutral:
 - 1. Circuits containing ground fault circuit interrupter devices.

2. Circuits containing solid state dimmers.
3. Circuits recommended by equipment manufacturers to have separate neutrals.

3.04 CONDUCTOR SIZE

- A. Conductor Size:
1. For Electric Light and Power Branch Circuits: Install conductors of size shown on drawings. Where size is not indicated, the minimum size allowed is No. 12 AWG.
 2. For Class 1 Circuits:
 - a. No. 18 and No. 16 AWG may be used provided they supply loads that do not exceed 6 amps (No. 18 AWG), or 8 amps (No. 16 AWG).
 - b. Larger than No. 16 AWG: Use to supply loads not greater than the ampacities given in NFPA 70 Section 310-15.
 3. For Class 2 Circuits: Any size to suit application.
 4. For Class 3 Circuits: Minimum No. 18 AWG.

3.05 COLOR CODING

- A. Color Coding for 120/208 Volt Electric Light and Power Wiring:
1. Color Code:
 - a. 2 wire circuit - black, white.
 - b. 3 wire circuit - black, red, white.
 - c. 4 wire circuit - black, red, blue, white.
 2. White to be used only for an insulated grounded conductor (neutral). If neutral is not required use black and red, or black, red and blue for phase to phase circuits.
 - a. "White" for Sizes No. 6 AWG or Smaller:
 - 1) Continuous white outer finish, or:
 - 2) Three continuous white stripes on other than green insulation along its continuous length.
 - b. "White" for Sizes Larger Than No. 6 AWG:
 - 1) Continuous white outer finish, or:
 - 2) Three continuous white stripes on other than green insulation along its continuous length, or:
 - 3) Distinctive white markings (color coding tape) encircling the conductor, installed on the conductor at time of its installation. Install white color coding tape at terminations, and at 1' 0" intervals in gutters, pullboxes, and manholes.
 3. Colors (Black, Red, Blue):
 - a. For Branch Circuits: Continuous color outer finish.
 - b. For Feeders:
 - 1) Continuous color outer finish, or:
 - 2) Color coding tapes encircling the conductors, installed on the conductors at time of their installation. Install color coding tapes at terminations, and at 1' 0" intervals in gutter, pullboxes, and manholes.
- B. Color Coding For 277/480 Volt Electric Light and Power Wiring:
1. Color Code:

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- a. 2 wire circuit – brown, gray.
 - b. 3 wire circuit – brown, yellow, gray.
 - c. 4 wire circuit – brown, yellow, orange, gray.
 2. Gray to be used only for an insulated grounded conductor (neutral). If neutral is not required use brown and yellow, or brown, yellow and orange for phase to phase circuits.
 - a. “Gray” For Sizes No. 6 AWG or Smaller.
 - 1) Continuous gray outer finish.
 - b. “Gray” For Sizes Larger Than No. 6 AWG:
 - 1) Distinctive gray markings (color coding tape) encircling the conductor, installed on the conductor at time of its installation. Install gray color coding tape at terminations, and at 1’ 0” intervals in gutters, pullboxes, and manholes.
 - c. Colors (Brown, Yellow, Orange):
 - d. For Branch Circuits: Continuous color outer finish.
 - e. For Feeders:
 - 1) Continuous color outer finish, or:
 - 2) Color coding tapes encircling the conductors, installed on the conductors at the time of their installation. Install color coding tapes at terminations, and at 1’ 0” intervals in gutters, pullboxes, and manholes.
- C. More Than One Nominal Voltage System Within A building: Permanently post the color coding scheme at each branch-circuit panelboard.
- D. Existing Color Coding Scheme: Where an existing color coding scheme is in use, match the existing color coding if it is in accordance with the requirements of NFPA 70.
- E. Color Code For Wiring Other Than Electric Light and Power: In accordance with ICEA/NEMA WC-30 “Color Coding of Wires and Cables”. Other coding methods may be used, as approved.

3.06 IDENTIFICATION

- A. Identification Tags: Use tags to identify feeders and designated circuits. Install tags so that they are easily read without moving adjacent feeders or requiring removal of arc proofing tapes. Attach tags with non-ferrous wire or brass chain.
1. Interior Feeders: Identify each feeder in pullboxes and gutters. Identify by feeder number and size.
 2. Exterior Feeders: Identify each feeder in manholes and in interior pullboxes and gutters. Identify by feeder number and size, and also indicate building number and panel designation from which feeder originates.
 3. Street and Grounds Lighting Circuits: Identify each circuit in manholes and lighting standard bases. Identify by circuit number and size, and also indicate building number and panel designation from which circuit originates.
- B. Identification Plaque: Where a building or structure is supplied by more than one service,

or has any combination of feeders, branch circuits, or services passing through it, install a permanent plaque or directory at each service, feeder and branch circuit disconnect location denoting all other services, feeders, or branch circuits supplying that building or structure or passing through that building or structure and the area served by each.

3.07 WIRE MANAGEMENT

- A. Use wire management products to bundle, route, and support wiring in junction boxes, pullboxes, wireways, gutters, channels, and other locations where wiring is accessible.

3.08 EQUIPMENT GROUNDING CONDUCTOR

- A. Install equipment grounding conductor:
 - 1. Where specified in other Sections or indicated on the drawings.
 - 2. In conjunction with circuits recommended by equipment manufacturers to have equipment grounding conductor.
- B. Equipment grounding conductor is not intended as a current carrying conductor under normal operating circumstances.
- C. Color Coding For Equipment Grounding Conductor:
 - 1. Color Code: Green.
 - 2. "Green" For sizes No. 6 AWG or Smaller:
 - a. Continuous green outer finish, or:
 - b. Continuous green outer finish with one or more yellow stripes, or:
 - c. Bare copper (see exception below).
 - 3. "Green" For Sizes Larger Than No. 6:
 - a. Stripping the insulation or covering from the entire exposed length (see exception below).
 - b. Marking the exposed insulation or covering with green color coding tapes.
 - c. Identify at each end and at every point where the equipment grounding conductor is accessible.

3.09 INSULATED CONDUCTOR AND CABLE SCHEDULE - TYPES AND USE

- A. Electric Light and Power Circuits:
 - 1. FEP, THHN, THW, THW-2, THWN, THWN-2, XHH, XHHW, or XHHW-2: Wiring in dry or damp locations (except where special type insulation is required).
 - 2. THWN, THWN-2, XHHW, XHHW-2, USE, or USE-2: Wiring in wet locations (except where type USE or USE-2 insulated conductors are specifically required, or special type insulation is required).
 - 3. THHN, THWN or THWN-2: Wiring installed in existing raceway systems (except where special type insulation is required).
 - 4. THHN, THW-2, THWN-2, XHHW, or XHHW-2: Wiring for electric discharge lighting circuits (fluorescent, HID), except where fixture listing requires wiring rated higher than 90° C.
 - 5. THWN Marked "Gasoline and Oil Resistant": Wiring to gasoline and fuel oil pumps.

3.10 CONNECTOR SCHEDULE - TYPES AND USE

- A. Temperature Rating: Use connectors that have a temperature rating, equal to, or greater than the temperature rating of the conductors to which they are connected.
- B. Splices:
 - 1. Dry Locations:
 - a. For Conductors No. 8 AWG or Smaller: Use spring type pressure connectors, indent type pressure connectors with insulating jackets, or connector blocks (except where special type splices are required).
 - b. For Conductors No. 6 AWG or Larger: Use connector blocks or uninsulated indent type pressure connectors. Fill indentions in uninsulated connectors with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with heat shrinkable splices or cold shrink splices.
 - c. Gutter Taps in Panelboards: For uninsulated type gutter taps fill indentions with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with gutter tap cover.
 - 2. Damp Locations: As specified for dry locations, except apply moisture sealing tape over the entire insulated connection (moisture sealing tape not required if heat shrinkable splices or cold shrink splices are used).
 - 3. Wet Locations: Use uninsulated indent type pressure connectors and insulate with resin splice kits, cold shrink splices or heat shrinkable splices. Exception: Splices above ground which are totally enclosed and protected in NEMA 3R, 4, 4X enclosures may be spliced as specified for damp locations.
 - 4. All splices shall be inside a adequately sized junction box per the National Electric Code.
- C. Terminations:
 - 1. For Conductors No. 10 AWG or Smaller: Use terminals for:
 - a. Connecting wiring to equipment designed for use with terminals.
 - 2. For Conductors No. 8 AWG or Larger: Use compression or mechanical type lugs for:
 - a. Connecting cables to flat bus bars.
 - b. Connecting cables to equipment designed for use with lugs.
 - 3. For Conductor Sizes Larger Than Terminal Capacity On Equipment: Reduce the larger conductor to the maximum conductor size that terminal can accommodate (reduced section not longer than one foot). Use compression or mechanical type connectors suitable for reducing connection.

END OF SECTION

SECTION 260529

FASTENERS, ATTACHMENTS, AND SUPPORTING DEVICES

PART 1 GENERAL

1.01 SUBMITTALS

- A. Shop Drawings: Show support details if different from methods specified or shown on the drawings.
- B. Product Data: Catalog sheets, specifications, and installation instructions.

PART 2 PRODUCTS

2.01 ANCHORING DEVICES

- A. Sleeve Anchors: Molly/Emhart's Parasleeve Series, Phillips' Red Head AN, HN, FS Series, or Ramset's Dynabolt Series.
- B. Wedge Anchors: Hilti's Kwik Bolt Series, Molly/Emhart's Parabolt Series, Phillips' Red Head WS, or Ramset's Trubolt Series.
- C. Self-Drilling Anchors: Phillips' Red Head Series S or Ramset's Ram Drill Series.
- D. Non-Drilling Anchors: Hilti's Drop-In Anchor Series, Phillips' Red Head J Series, or Ramset's Dynaset Series.
- E. Stud Anchors: Phillips' Red Head JS Series.

2.02 CAST-IN-PLACE CONCRETE INSERTS

- A. Continuous Slotted Type Concrete Insert, Galvanized:
 - 1. Load Rating 1300 lbs./ft.: Kindorf's D-986.
 - 2. Load Rating 2400 lbs./ft.: Kindorf's D-980.
 - 3. Load Rating 3000 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-H.
 - 4. Load Rating 4500 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-HD.
- B. Threaded Type Concrete Insert: Galvanized ferrous castings, internally threaded.
- C. Wedge Type Concrete Insert: Galvanized box-type ferrous castings, designed to accept bolts having special wedge shaped heads.

2.03 MISCELLANEOUS FASTENERS

- A. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work, selected from the following:

Furnish galvanized fasteners for exterior use, or for items anchored to exterior walls, except where stainless steel is indicated.

1. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
2. Lag Screws: ASME B18.2.1.
3. Machine Bolts: ASME B18.5 or ASME B18.9, Type, Class, and Form as required.
4. Wood Screws: Flat head, ASME B18.6.1.
5. Plain Washers: Round, ASME B18.22.1.
6. Lock Washers: Helical, spring type, ASME B18.21.1.
7. Toggle Bolts: Spring Wing Type; Wing AISI 1010, Trunion Nut AISI1010 or Zamac Alloy, Bolt Carbon Steel ANSI B18.6.3.

- B. Stainless Steel Fasteners: Type 302 for interior Work; Type 316 for exterior Work; Phillips head screws and bolts for exposed Work unless otherwise specified.

2.04 TPR (THE PEEL RIVET) FASTENERS

- A. 1/4 inch diameter, threadless fasteners distributed by Subcon Products, 315 Fairfield Road, Fairfield, NJ 07004 (800) 634-5979.

2.05 POWDER DRIVEN FASTENER SYSTEMS

- A. Olin Corp.'s Ramset Fastening Systems, or Phillips Drill Company Inc.'s Red Head Powder Actuated Systems.

2.06 HANGER RODS

- A. Mild low carbon steel, unless otherwise specified; fully threaded or threaded each end, with nuts as required to position and lock rod in place. Unless galvanized or cadmium plated, provide a shop coat of red lead or zinc chromate primer paint.

2.07 "C" BEAM CLAMPS

- A. With Conduit Hangers:
1. For 1 Inch Conduit Maximum: B-Line Systems Inc.'s BG-8, BP-8 Series, Caddy/Erico Products Inc.'s BC-8P and BC-8PSM Series, or GB Electrical Inc.'s HIT 110-412 Series.
 2. For 3 Inch Conduit Maximum: Appleton Electric Co.'s BH-500 Series beam clamp with H50W/B Series hangers, Kindorf's 500 Series beam clamp with 6HO-B Series hanger, or OZ/Gedney Co.'s IS-500 Series beam clamp with H-OWB Series hanger.
 3. For 4 Inch Conduit Maximum: Kindorf's E-231 beam clamp and E-234 anchor clip and C-149 series lay-in hanger; Unistrut Corp.'s P2676 beam clamp and P-1659A Series anchor clip with J1205 Series lay in hanger.
- B. For Hanger Rods:
1. For 1/4 Inch Hanger Rods: B-Line Systems Inc.'s BC, Caddy/Erico Products Inc.'s BC, GB Electrical Inc.'s HIT 110, Kindorf's 500, 510, or Unistrut Corp.'s P1648S, P2398S, P2675, P2676.

2. For 3/8 Inch Hanger Rods: Caddy/Erico Products Inc.'s BC, Kindorf's 231-3/8, 502, or Unistrut Corp.'s P1649AS, P2401S, P2675, P2676.
3. For 1/2 Inch Rods: Appleton Electric Co. BH-500 Series, Kindorf's 500 Series, 231-1/2, OZ/Gedney Co.'s IS-500 Series, or Unistrut Corp.'s P1650AS, P2403S, P2676.
4. For 5/8 Inch Rods: Unistrut Corp.'s P1651AS beam clamp and P1656A Series anchor clip.
5. For 3/4 Inch Rods: Unistrut Corp.'s P1653S beam clamp and P1656A Series anchor clip.

2.08 CHANNEL SUPPORT SYSTEM

- A. Channel Material: 12 gage steel.
- B. Finishes:
 1. Phosphate and baked green enamel/epoxy.
 2. Pre-galvanized.
 3. Electro-galvanized.
 4. Hot dipped galvanized.
 5. Polyvinyl chloride (PVC), minimum 15 mils thick.
- C. Fittings: Same material and finish as channel.
- D. UL Listed Systems:
 1. B-Line Systems Inc.'s B-22 (1-5/8 x 1-5/8 inches), B-12 (1-5/8 x 2-7/16 inches), B-11 (1-5/8 x 3-1/4 inches).
 2. Grinell Corp.'s Allied Power-Strut PS 200 (1-5/8 x 1-5/8 inches), PS 150 (1-5/8 x 2-7/16 inches), PS 100 (1-5/8 x 3-1/4 inches).
 3. Kindorf's B-900 (1-1/2 x 1-1/2 inches), B-901 (1-1/2 x 1-7/8 inches), B-902 (1-1/2 x 3 inches).
 4. Unistrut Corp.'s P-3000 (1-3/8 x 1-5/8 inches), P-5500 (1-5/8 x 2-7/16 inches), P-5000 (1-5/8 x 3-1/4 inches).
 5. Versabar Corp.'s VA-1 (1-5/8 x 1-5/8 inches), VA-3 (1-5/8 x 2-1/2 inches).

2.09 MISCELLANEOUS FITTINGS

- A. Side Beam Brackets: B-Line Systems Inc.'s B102, B103, B371-2, Kindorf's B-915, or Versabar Corp.'s VF-2305, VF-2507.
- B. Pipe Straps:
 1. Two Hole Steel Conduit Straps: B-Line Systems Inc.'s B-2100 Series, Kindorf's C-144 Series, or Unistrut Corp.'s P-2558 Series.
 2. One Hole Malleable Iron Clamps: Kindorf's HS-400 Series, or OZ/Gedney Co.'s 14-G Series, 15-G Series (EMT).
- C. Deck Clamps: Caddy/Erico Products Inc.'s DH-4-T1 Series.
- D. Fixture Stud and Strap: OZ/Gedney Co.'s SL-134, or Steel City's FE-431.

- E. Supporting Fittings for Pendent Mounted Industrial Type Fluorescent Fixtures on Exposed Conduit System:
 - 1. Ball Hanger: Appleton Electric Co.'s AL Series, or Crouse-Hinds Co.'s AL Series.
 - 2. Flexible Fixture Hanger: Appleton Electric Co.'s UNJ-50, UNJ-75, or Crouse-Hinds Co.'s UNJ115.
 - 3. Flexible (Hook Type) Fixture Hanger: Appleton Electric Co.'s FHMF, or Crouse-Hinds Co.'s UNH-1.
 - 4. Eyelet: Unistrut Corp.'s M2250.
 - 5. Eyelet with Stud: Kindorf's H262, or Unistrut Corp.'s M2350.
 - 6. Conduit Hook: Appleton Electric Co.'s FHSN, or Crouse-Hinds Co.'s UNH-13.
- F. Supporting Fasteners (Metal Stud Construction): Metal stud supports, clips and accessories as produced by Caddy/Erico Products Inc.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Where specific fasteners are not specified or indicated for securing items to in-place construction, provide appropriate type, size, and number of fasteners for a secure, rigid installation.
- B. Install anchoring devices and other fasteners in accordance with manufacturer's printed instructions.
- C. Make attachments to structural steel wherever possible.

3.02 FASTENER SCHEDULE

- A. Material:
 - 1. Use cadmium or zinc coated anchors and fasteners in dry locations.
 - 2. Use hot dipped galvanized or stainless steel anchors and fasteners in damp and wet locations.
 - 3. For corrosive atmospheres or other extreme environmental conditions, use fasteners made of materials suitable for the conditions.
- B. Types and Use: Unless otherwise specified or indicated use:
 - 1. Cast-in-place concrete inserts in fresh concrete construction for direct pull-out loads such as shelf angles or fabricated metal items and supports attached to concrete slab ceilings.
 - 2. Anchoring devices to fasten items to solid masonry and concrete when the anchor is not subjected to pull out loads, or vibration in shear loads.
 - 3. Toggle bolts to fasten items to hollow masonry and stud partitions.
 - 4. TPR fasteners to fasten items to plywood backed gypsum board ceilings.
 - 5. Metallic fasteners installed with electrically operated or powder driven tools for approved applications, except:
 - a. Do not use powder driven drive pins or expansion nails.

- b. Do not attach powder driven or welded studs to structural steel less than 3/16 inch thick.
- c. Do not support a load, in excess of 250 lbs from any single welded or powder driven stud.
- d. Do not use powder driven fasteners in precast concrete.

3.03 ATTACHMENT SCHEDULE

- A. General: Make attachments to structural steel or steel bar joists wherever possible. Provide intermediate structural steel members where required by support spacing. Select steel members for use as intermediate supports based on a minimum safety factor of 5.
 - 1. Make attachments to steel bar joists at panel points of joists.
 - 2. Do not drill holes in main structural steel members.
 - 3. Use "C" beam clamps for attachment to steel beams.
- B. Where it is not possible to make attachments to structural steel or steel bar joists, use the following methods of attachment to suit type of construction unless otherwise specified or indicated on the drawings:
 - 1. Attachment to Steel Roof Decking (No Concrete Fill):
 - a. Decking With Hanger Tabs: Use deck clamps.
 - b. Decking Without Hanger Tabs:
 - 1) Before Roofing Has Been Applied: Use 3/8 inch threaded steel rod welded to a 4 x 4 x 1/4 inch steel plate and installed through 1/2 inch hole in roof deck.
 - 2) After Roofing Has Been Applied: Use welding studs, or self-drilling/tapping fasteners. Exercise extreme care when installing fasteners to avoid damage to roofing.
 - 2. Attachment to Concrete Filled Steel Decks (Total thickness, 2-1/2 inches or more):
 - a. Before Fill Has Been Placed:
 - 1) Use thru-bolts and fish plates.
 - 2) Use welded studs. Do not support a load in excess of 250 pounds from a single welded stud.
 - b. After Fill Has Been Placed: Use welded studs. Do not support a load in excess of 250 lbs from a single welded stud.
 - 3. Attachment to Cast-In-Place Concrete:
 - a. Fresh Concrete: Use cast-in-place concrete inserts.
 - b. Existing Concrete: Use anchoring devices.
 - 4. Attachment to Cored Precast Concrete Decks:
 - a. New Construction: Use thru-bolts and fish plates before Construction Work Contractor has placed concrete fill over decks.
 - b. Existing Construction: Toggle bolts may be installed in cells for a maximum load of _____.
 - 5. Attachment to Hollow Block or Tile Filled Concrete Deck:
 - a. New Construction: Use cast-in-place concrete inserts by having Construction Work Contractor omitting blocks and pouring solid blocks with insert where required.
 - 6. Attachment to Waffle Type Concrete Decks:
 - a. New Construction:

- 1) Use cast-in-place concrete inserts in fresh concrete.
- 2) If concrete fill has been applied over deck, thru-bolts and fish plates may be used where additional concrete or roofing is to be placed over the deck.
7. Attachment to Precast Concrete Planks: Use anchoring devices, except do not make attachments to precast concrete planks less than 2-3/4 inches thick.
8. Attachment to Precast Concrete Tee Construction:
 - a. New Construction:
 - 1) Use tee hanger inserts between adjacent flanges.
 - 2) Use thru-bolts and fish plates, except at roof deck without concrete fill.
 - b. Existing Construction:
 - 1) Use anchoring devices installed in webs of tees. Install anchoring devices as high as possible in the webs.
 - c. Do not use powder driven fasteners.
 - d. Exercise extreme care in drilling holes to avoid damage to reinforcement.
9. Attachment to Wood Construction: Use side beam brackets fastened to the sides of wood members to make attachments for hangers.
 - a. Under 15 lbs Load: Attach side beam brackets to wood members with 2 No. 18 x 1-1/2 inch long wood screws, or 2 No. 16 x 1-1/2 inch long drive screws.
 - b. Over 15 lbs Load: Attach side beam brackets to wood members with bolts and nuts or lag bolts. Do not use lag bolts in wooden members having a nominal thickness (beam face) under 2 inches in size. Install bolts and nuts or lag bolts in the side of wood members at the mid-point or slightly above. Install plain washers under all nuts.

LOAD	LAG BOLT SIZE	BOLT DIAMETER
15 lbs to 30 lbs	3/8 x 1-3/4 inches	3/8 inch
31 lbs to 50 lbs	1/2 x 2 inches	1/2 inch
Over 50 lbs to load limit of structure.	Use bolt & nut.	5/8 inch

- c. Bottom chord of wood trusses may be utilized as structural support, but method of attachment must be specifically approved.
- d. Do not make attachments to the diagonal or vertical members of wood trusses.
- e. Do not make attachments to the nailing strips on top of steel beams.
10. Attachment to Metal Stud Construction: Use supporting fasteners manufactured specifically for the attachment of raceways and boxes to metal stud construction.
 - a. Support and attach outlet boxes so that they cannot torque/twist. Either:
 - 1) Use bar hanger assembly, or:
 - 2) In addition to attachment to the stud, also provide far side box support.

3.04 CONDUIT SUPPORT SCHEDULE

- A. Provide number of supports as required by National Electrical Code. Exception: Maximum support spacing allowed is 4'-0" for conduit sizes 3 inches and larger supported from wood trusses.
- B. Use pipe straps and specified method of attachment where conduit is installed proximate to surface of wood or masonry construction.
 - 1. Use hangers secured to surface with specified method of attachment where conduit is suspended from the surface.
- C. Use "C" beam clamps and hangers where conduit is supported from steel beams.
- D. Use deck clamps and hangers where conduit is supported from steel decking having hanger tabs.
 - 1. Where conduit is supported from steel decking that does not have hanger tabs, use clamps and hangers secured to decking, utilizing specified method of attachment.
- E. Use channel support system supported from structural steel for multiple parallel conduit runs.
- F. Where conduits are installed above ceiling, do not rest conduit directly on runner bars, T-Bars, etc.
 - 1. Conduit Sizes 2-1/2 Inches and Smaller: Support conduit from ceiling supports or from construction above ceiling.
 - 2. Conduit Sizes Over 2-1/2 Inches: Support conduit from beams, joists, or trusses above ceiling.

3.05 LIGHTING FIXTURE SUPPORT SCHEDULE

- A. General: Do not support fixtures from ceilings or ceiling supports unless it is specified or indicated on the drawings to do so.
 - 1. Support fixtures with hanger rods attached to beams, joists, or trusses. Hanger rod diameter, largest standard size that will fit in mounting holes of fixture.
 - a. Where approved, channel supports may span and rest upon the lower chord of trusses and be utilized for the support of lighting fixtures.
 - b. Where approved, channel supports may span and be attached to the underside of beams, joists, or trusses and be utilized for the support of lighting fixtures.
 - 2. Use 2 nuts and 2 washers on lower end of each hanger rod to hold and adjust fixture (one nut and washer above top of fixture housing, one nut and washer below top of fixture housing).
 - a. Where specified that an adequately supported outlet box is to support a fixture or be utilized as one point of support, support the box so that it may be adjusted to bring the face of the outlet box even with surface of ceiling.

- B. Specific Installations Where Fixtures May Be Supported From New Ceilings Being Installed By Construction Work Contractor:
1. Support surface mounted fluorescent fixtures and incandescent fixtures directly from plywood backed gypsum board ceilings.
 2. Support surface mounted fluorescent fixtures and incandescent fixtures directly from framing or furring members of fire rated suspended ceilings (double gypsum board).
 3. Support recessed mounted fluorescent fixtures and incandescent fixtures directly from furring members of furred gypsum board ceilings.
 4. Support recessed mounted fluorescent fixtures and incandescent fixtures directly from the suspension system of suspended acoustical ceilings.
Exception: Support each fixture weighing more than 50 pounds (including lamps) independent of the suspended ceiling grid.
 5. Deliver documents that state actual fixture weights and indicate fixture locations to the Construction Work Contractor (thru the Director's Representative).
- C. Number of Supports For Ceiling Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer, or shown on the drawings.
1. Commercial and Industrial Fluorescent Fixtures:
 - a. Support individual fluorescent fixtures less than 2 feet wide at 2 points.
 - b. Support continuous row fluorescent fixtures less than 2 feet wide at points equal to the number of fixtures plus one. Uniformly distribute the points of support over the row of fixtures.
 - c. Support individual fluorescent fixtures 2 feet or wider at 4 corners.
 - d. Support continuous row fluorescent fixtures 2 feet or wider at points equal to twice the number of fixtures plus 2. Uniformly distribute the points of support over the row of fixtures.
 - e. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.
 2. Vandal Resistant, and Minimum Security Fluorescent Fixtures:
 - a. Support individual fluorescent fixtures less than 2 feet wide at 4 corners.
 - b. Support continuous row fluorescent fixtures less than 2 feet wide at points equal to twice the number of fixtures. Uniformly distribute the points of support.
 - c. Support individual fluorescent fixtures 2 feet or wider at each corner and one support midway along each side of longest axis (6 supports total).
 - d. Support continuous row fluorescent fixtures 2 feet or wider at points equal to 4 times the number of fixtures. Uniformly distribute the points of support.
 - e. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.
 3. Medium Security Fluorescent Fixtures: Support each fixture at minimum of 6 points (each corner and midway along each side of longest axis). Outlet box shall not be counted as a point of support.

4. Maximum Security Fluorescent Fixtures: Support each fixture at minimum of 8 points (each corner, and 2 supports spaced equally along each side of longest axis). Outlet box shall not be counted as a point of support.
 5. Mercury Vapor, Metal Halide, and High Pressure Sodium Fixtures:
 - a. Commercial Style: Support fixture at 2 points.
 - b. Industrial Style: Support individual fixtures at one point.
 - c. Vandal Resistant Style: Support fixture at 4 points.
 - d. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.
 6. Commercial and Industrial Incandescent Fixtures: Support fixture from adequately supported outlet box, to suit fixture design (fixture weight less than 50 pounds).
 7. Vandal Resistant Incandescent Fixtures: Support fixture from adequately supported outlet box to suit fixture design, plus 2 fasteners through back of fixture into suitable construction behind fixture.
- D. Number of Supports For Wall Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer, or shown on the drawings.
1. Commercial and Industrial Fluorescent Fixtures:
 - a. Support individual fluorescent fixtures 2 feet long or less at 2 points.
 - b. Support individual fluorescent fixtures over 2 feet long at 3 points.
 - c. Support continuous row fluorescent fixtures at points equal to twice the number of fixtures. Uniformly distribute the points of support.
 - d. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.
 2. Vandal Resistant, and Minimum Security Fluorescent Fixtures:
 - a. Support individual fluorescent fixtures 2 feet long or less at 4 points (each corner).
 - b. Support individual fluorescent fixtures over 2 feet long at 6 points (each corner and midway along each side of longest axis).
 - c. Support continuous row fluorescent fixtures at points equal to 6 times the number of fixtures. Uniformly distribute the points of support.
 - d. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.
 3. Medium Security, and Maximum Security Fluorescent Fixtures:
 - a. Support each fluorescent fixture 2 feet long or less at minimum of 4 points (each corner).
 - b. Support each fluorescent fixture over 2 feet long, to 3 feet long at a minimum of 6 points (each corner and midway along each side of longest axis).
 - c. Support each fluorescent fixture over 3 feet long, to 8 foot long at minimum of 8 points (each corner, and 2 supports spaced equally along each side of longest axis).
 - d. Outlet box shall not be counted as a point of support.
 4. Mercury Vapor, Metal Halide, and High Pressure Sodium Fixtures:

- a. Commercial and Industrial Style: Support fixture at 2 points (Support arm mounted style at 4 points).
 - b. Vandal Resistant Style: Support fixture at 4 points.
 - c. An adequately supported outlet box may be used as one point of support for fixtures weighing less than 50 pounds.
5. Commercial and Industrial Incandescent Fixtures: Support fixture from adequately supported outlet box, to suit fixture design (fixture weight less than 50 pounds).
 6. Vandal Resistant Incandescent Fixtures: Support fixture from adequately supported outlet box to suit fixture design, plus 2 fasteners through back of fixture into suitable construction behind fixture.

3.06 CHANNEL SUPPORT SYSTEM SCHEDULE

- A. Use channel support system where specified or indicated on the drawings.
- B. Channel supports may be used, as approved, to accommodate mounting of equipment.
- C. Material and Finish:
 1. Dry Locations: Use 12 gage steel channel support system having any one of the specified finishes.
 2. Damp Locations: Use 12 gage steel channel support system having any one of the specified finishes except green epoxy/enamel.
 3. Wet Locations: Use 12 gage steel channel support system having hot dipped galvanized, or PVC finish.

END OF SECTION

SECTION 260532

RACEWAYS, FITTINGS, AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

- A. NEMA, ANSI, and UL.

1.02 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.

1.03 MAINTENANCE

- A. Spare Parts: Furnish the following items in the manufacturer's original containers labeled with the names of the items and locations where the items would be used. Store them at the site where directed:
 - 1. Touch up coating compound for plastic coated rigid metal conduit (one spray type can and one non-spray can with brush top).

PART 2 PRODUCTS

2.01 RACEWAYS

- A. Rigid Ferrous Metal Conduit: Steel, hot dipped galvanized on the outside and inside, UL categorized as Rigid Ferrous Metal Conduit (identified on UL Listing Mark as Rigid Metal Conduit - Steel or Rigid Steel Conduit), by Allied Tube & Conduit Corp., LTV Copperweld, or Wheatland Tube Co.
- B. Intermediate Ferrous Metal Conduit: Steel, galvanized on the outside and enameled on the inside, UL categorized as Intermediate Ferrous Metal Conduit (identified on UL Listing Mark as Intermediate Metal Conduit or IMC), by Allied Tube & Conduit Corp., LTV Copperweld, or Wheatland Tube Co.
- C. Electrical Metallic Tubing: Steel, galvanized on the outside and enameled on the inside, UL categorized as Electrical Metallic Tubing (identified on UL Listing Mark as Electrical Metallic Tubing), by Allied Tube & Conduit Corp., LTV Copperweld, or Wheatland Tube Co.
- D. Flexible Metal Conduit: Galvanized steel strip shaped into interlocking convolutions, UL categorized as Flexible Metal Conduit (identified on UL Listing Mark as Flexible Steel Conduit or Flexible Steel Conduit Type RW), by AFC Cable Systems Inc., Anamet Electrical Inc., Electri-Flex Co., or International Metal Hose Co.

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- E. Liquid-tight Flexible Metal Conduit: UL categorized as liquid-tight flexible metal conduit (identified on UL Listing Mark as Liquid-Tight Flexible Metal Conduit, also specifically marked with temperature and environment application data), by AFC Cable Systems Inc., Anamet Electrical Inc., Electri-Flex Co., or Universal Metal Hose Co.
- F. Rigid Nonmetallic PVC Conduit, Fittings, and Accessories: UL categorized as Rigid Nonmetallic, Schedule 40 and Schedule 80 PVC conduit (identified on UL Listing Mark as Rigid Nonmetallic Conduit Aboveground and Underground Schedule 40; Rigid Nonmetallic Conduit Aboveground and Underground Extra Heavy Wall Schedule 80), by Beck Mfg./Picoma Industries, Cantex Inc., Carlon/Div. Of Lamson and Sessions, Ipex Inc., J-M Mfg. Co. Inc., National Pipe & Plastics Inc., or Queen City Plastics Inc.
- G. Surface Metal Raceway, Fittings and Accessories: By Thomas & Betts Corp., Mono-Systems Inc. or Wiremold Co. Area and conductor capacity indicated for each size raceway is for reference. Follow manufacturer's recommended raceway capacity for all types and sizes of conductors:
 - 1. Size 1: Nominal area .3 sq. in. min., 4 No. 12 THW max.; Thomas & Betts B400, Mono-Systems SMS 700, or Wiremold's V700.
 - 2. Size 2: Nominal area .75 sq. in. min., 11 No. 12 THW max.; Thomas & Betts SR250, Mono-Systems SMS2100, Wiremold's 2100.
 - 3. Size 3: Nominal area 2.8 sq. in. min., 43 No. 12 THW max.; Thomas & Betts SR500, Mono-Systems SMS3200, or Wiremold's G3000.
 - 4. Size 4: Nominal area 7.5 sq. in. min., 119 No. 12 THW max.; Thomas & Betts SR600, Mono-Systems SMS4200, or Wiremold's G4000.
 - 5. Size 5: Nominal area 15.9 sq. in. min., 252 No. 12 THW max.; Thomas & Betts SR700, Mono-Systems SMS4400, or Wiremold's G6000.
- H. Multioutlet Assembly, Fittings and Accessories:
 - 1. Type 1: Mono-System Inc.'s Snap Strip 1900 Series, or Wiremold Co.'s Plugmold 2000 System, nominal 1-9/32 inch wide base in 3, 5, 6, or 10 foot lengths or combinations to suit installation. Outlets in cover, spaced 12 inches on center.
 - 2. Type 2: Mono-Systems Inc.'s SnapMark SMS 2100 Series, or Wiremold Co.'s 2100 System, nominal 1-1/4 inch wide base in 10 foot lengths joined to suit installation. Outlet spacing as indicated on drawings.
 - 3. Type 3: Mono-Systems Inc.'s SnapMark SMS3200 Series, or Wiremold Co.'s G3000 System, nominal 2-3/4 inch wide raceway base and cover in 5 or 10 foot lengths, joined to suit installation. Outlet types and spacing as indicated on drawings.
 - 4. Type 4: Mono-Systems Inc.'s SnapMark SMS4200 Series, or Wiremold Co.'s G4000 System, nominal 4-3/4 inch wide by 1-3/4 inch deep raceway base and cover in 5 or 10 foot lengths, joined to suit installation. Outlet types and spacing as indicated on drawings.
 - 5. Type 5: Mono-Systems Inc.'s SnapMark SMS4400 Series, or Wiremold Co.'s G6000 System, nominal 4-3/4 inch wide by 3-9/16 inch deep raceway base in 5 or 10 foot lengths, joined to suit installation. Outlet types and spacing as indicated on drawings.

- I. Wireways, Fittings and Accessories:
 - 1. NEMA 1 (Without Knockouts): Hoffman Enclosures Inc. Bulletin F-40, Hubbell/Wegmann's HSK, Lee Products Co.'s S Series, Rittal/Electromate's EW & EWHC Lay-In Wireway System, or Square D Co.'s Square-Duct Class 5100.

2.02 FITTINGS AND ACCESSORIES

- A. Insulated Bushings:
 - 1. Threaded, malleable iron/zinc electroplate with 105 degrees C minimum plastic insulated throat; Appleton Electric Co.'s BU50I Series, Cooper/Crouse-Hinds' 1031 Series, OZ/Gedney Co.'s IBC-50 Series, Racco Inc.'s 1132 Series, Steel City/T & B Corp.'s BI-901 Series, or Thomas & Betts Corp.'s 1222 Series.
 - 2. Threaded malleable iron with 150 degrees C plastic throat; Appleton Electric Co.'s BU50I Series, Cooper/Crouse-Hinds' H1031 Series, or OZ/Gedney Co.'s IBC-50 Series.
- B. Plastic Bushings for 1/2 and 3/4 Inch Conduit:
 - 1. 105 degrees C minimum temperature rating; Appleton Electric Co.'s BBU50, BBU75, Blackburn (T & B Corp.'s) 50 BB, 75 BB, Cooper/Crouse-Hinds' 931,932, or OZ/Gedney Co.'s IB-50, IB-75, Racco Inc.'s 1402, 1403, Steel City/T & B Corp.'s BU-501, BU-502, or Thomas & Betts Corp.'s 222, 223.
 - 2. 150 degrees C temperature rating; Appleton Electric Co.'s BBU50H, BBU75H, Cooper/Crouse-Hinds' H-931, H-932, or OZ/Gedney Co.'s A-50, A-75.
- C. Insulated Grounding Bushings:
 - 1. Threaded, malleable iron/zinc electroplate with 105 degrees C minimum plastic insulated liner, and ground lug; Appleton Electric Co.'s GIB-50 Series, Cooper/Crouse-Hinds' GLL Series, OZ/Gedney Co.'s IBC-50L Series, Racco Inc.'s 1212 Series, Steel City/T & B Corp.'s BG-801 (1/2 to 2") Series, or Thomas & Betts Corp.'s 3870.
 - 2. Threaded malleable iron/zinc electroplate with 150 degrees C plastic insulated liner, and ground lug; Appleton Electric Co.'s GIB Series, Cooper/Crouse-Hinds' HGLL Series, or OZ/Gedney Co.'s IBC-50L Series, or Thomas & Betts Corp.'s 3870.
- D. Connectors and Couplings:
 - 1. Locknuts: UL, steel/zinc electroplate; Appleton Electric Co.'s BL-50 Series, Cooper/Crouse-Hinds' 11 Series, OZ/Gedney Co.'s 1-50S Series, Racco Inc.'s 1002 Series, Steel City/T&B Corp.'s LN-101 Series, or Thomas & Betts Corp.'s 141 Series.
 - 2. Grounding Wedge: Thomas & Betts Corp.'s 3650 Series.

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3. Couplings For Rigid Metal and IMC Conduit: Standard galvanized threaded couplings as furnished by conduit manufacturer, Allied Tube & Conduit Corp.'s Kwik-Couple, or Thomas & Betts Corp.'s Shamrock.
 4. Three Piece Conduit Coupling For Rigid Metal and IMC Conduit: Steel, malleable iron, zinc electroplate; Allied Tube & Conduit Corp.'s Kwik-Couple, Appleton Electric Co.'s EC-50 Series, Cooper/Crouse-Hinds' 190M Series, OZ/Gedney Co.'s 4-50 Series, Raco Inc.'s 1502 Series, Steel City/T & B Corp.s EK-401 Series, or Thomas & Betts Corp.'s 675 Series.
 5. Electrical Metallic Tubing Couplings and Insulated Connectors: Compression type, steel/zinc electroplate; Appleton Electric Co.'s TW-50CS1, TWC-50CS Series, Cooper/Crouse-Hinds' 1650, 660S Series, Raco Inc.'s 2912, 2922 Series, Steel City/T & B Corp.'s TC-711 Series, or Thomas & Betts Corp.'s 5120, 5123 Series.
 6. Flexible Metal Conduit Connectors: Arlington Industries Inc.'s Saddle-Grip, OZ/Gedney Co.'s C-8T, 24-34T, ACV-50T Series, or Thomas & Betts Corp.'s Nylon Insulated Tite-Bite Series.
 7. Liquid-tight Flexible Metal Conduit Connectors: Steel, malleable iron, zinc electroplate, insulated throat; Appleton Electric Co.'s STB Series, Cooper/Crouse-Hinds' LTB Series, OZ/Gedney Co.'s 4Q-50T Series, Raco Inc.'s 3512 Series, Steel City/T & B Corp.'s LT-701 Series, or Thomas & Betts Corp.'s 5332 Series.
- E. Conduit Bodies (Threaded):
1. Malleable Iron/Zinc Electroplate: Zinc electroplate malleable iron or cast iron alloy bodies with zinc electroplate steel covers; Appleton Electric Co.'s Unilets, Cooper/Crouse-Hinds' Condulets, OZ/Gedney Co.'s Conduit Bodies, or Thomas & Betts Corp.'s Conduit Bodies.
- F. Expansion Fittings:
1. Malleable Iron, Zinc Electroplate Finish: Appleton Electric Co.'s XJ or OZ/Gedney Co.'s AX (TX for EMT), with external bonding jumper.
 2. Electrogalvanized Steel: Cooper/Crouse-Hinds' XJG (XJG-EMT for EMT), or Thomas & Betts Corp.'s XJG, with internal grounding.
- G. Deflection Fittings: Appleton Electric Co.'s DF, Cooper/Crouse-Hinds' XD, or OZ/Gedney Co.'s Type DX.
- H. Hazardous Location Fittings:
1. Sealing Fittings: Appleton Electric Co.'s EYS, ESU w/Kwiko sealing compound and fiber filler, Cooper/Crouse-Hinds' EYS, EZS w/Chico A sealing compound and Chico X filler, OZ/Gedney Co.'s EY, EYA with EYC sealing compound and EYF damming fiber, or Thomas & Betts Corp.'s. EYS w/Chico A sealing compound and Chico X filler.
 2. Other Type Fittings: As required to suit installation requirements, by Appleton Electric Co., Cooper/Crouse-Hinds, OZ/Gedney Co, or Thomas & Betts Corp.
- I. Sealant for Raceways Exposed to Different Temperatures: Sealing compounds and accessories to suit installation; Appleton Electric Co.'s DUC, or Kwiko Sealing Compound with fiber filler, Cooper/Crouse-Hinds' Chico A Sealing

Compound with Chico X fiber, Electrical Products Division 3M Scotch products, OZ Gedney Co.'s DUX or EYC sealing compound with EYF damming fiber, or Thomas & Betts Corp.'s Blackburn DX.

- J. Vertical Conductor Supports: Kellems/Hubbell Inc.'s Conduit Riser Grips, or OZ/Gedney Co.'s Type M, Type R.
- K. Pulling-In-Line For Installation in Spare and Empty Raceways: Polypropylene monofilament utility line; Greenlee Textron Inc.'s Poly Line 430, 431, or Ideal Industries Powr-Fish Pull-Line 31-340 Series.

PART 3 EXECUTION

3.01 RACEWAY INSTALLATION - GENERAL

- A. Number of Raceways: Do not change number of raceways to less than the number indicated on the drawings.
 - 1. Each raceway shall enclose one circuit unless otherwise indicated on the drawings.
- B. Number of Raceways: Do not change number of raceways to less than the number indicated on the drawings except when appropriate for advantageous reuse of existing exposed and concealed raceways (the contract documents do not indicate location, number, size or condition of existing raceways). Existing raceways may be reused if the following conditions are met:
 - 1. The existing raceway must be of adequate size for the new conductors to be installed therein (NFPA 70 Chapter 9, Tables 1, 4, & 5; Appendix C, Tables C1-C12a). More circuits may be enclosed by existing raceways than the circuiting shown on the drawings provided conductor sizes are increased to compensate for derating (adjustment factors) and other considerations required by NFPA 70 Article 310-15.
 - 2. Remove existing conductors.
 - 3. Demonstrate to the Director's Representative that the existing raceway is clear of obstructions and in good condition.
 - 4. Check ground continuity. When ground continuity of existing raceway is inadequate install insulated grounding bushings, grounding wedges, bonding straps, grounding jumpers or equipment grounding conductors to establish effective path to ground.
 - 5. Install insulated bushings to replace damaged or missing bushings. Replace non-insulated bushings with insulated bushings on raceway sizes 1 inch and larger.
 - 6. Install vertical conductor supports to replace existing or missing vertical conductor supports.
 - 7. Install extension rings on existing boxes when the number of new conductors installed therein exceeds NFPA 70 requirements.
 - 8. Furnish the Director's Representative with marked up drawings showing size and routing of existing raceways with number and size of new

conductors installed therein. The drawings will be forwarded to the design engineer for verification of NFPA 70 compliance.

- C. Raceways for Future Use (Spare Raceways and Empty Raceways): Draw fish tape through raceways in the presence of the Director's Representative to show that the raceway is clear of obstructions.
 - 1. Leave a pulling-in line in each spare and empty raceway.
- D. Conduit Installed Concealed:
 - 1. Install conduit concealed unless otherwise indicated on the drawings.
 - 2. Existing Construction:
 - a. Run conduit in existing chases and hung ceilings.
 - b. If conduit cannot be installed concealed due to conditions encountered in the building, report such conditions and await approval in writing before proceeding.
 - 3. New Construction:
 - a. Run conduit in the ceilings, walls, and partitions.
 - b. Conduit may not be installed in concrete floor slab (concrete slabs that are both ceilings and floors shall be treated as floor slabs).
 - c. Install conduit in concrete slabs, under slabs on grade, or under slabs above finished ceilings where indicated on the drawings. Concrete slabs that are both ceilings and floors shall be treated as floor slabs.
 - 1) Conduit in Slab: Run 1/2 and 3/4 inch conduit in the slab where placement of reinforcement and slab thickness is sufficient to allow 1-1/2 inches of concrete cover over conduit, otherwise run conduit under slab. Run conduit one inch and larger in the slab in the specific location(s) where it is indicated on the drawing to be run in the slab, otherwise run conduit under slab.
 - a) Run conduit under reinforcement where reinforcement is in upper portion or middle of slab.
 - b) Run conduit over reinforcement where reinforcement is in lower portion of slab.
 - c) Run conduit between reinforcement where reinforcement is in upper and lower portions of slab.
 - d) Separate parallel conduits minimum of 2 inches so that each conduit will be enveloped in concrete.
 - e) Pass conduit over steel beams, if any, parallel with the reinforcement.
 - f) Tie down conduit to avoid movement during placement of concrete.
 - g) Demonstrate to the Director's Representative that conduit has been placed to allow minimum of 1-1/2 inches of concrete cover.
 - 2) Conduit Under Slab on Grade:

- a) Run conduit under vapor barrier, if any.
 - b) Install equipment grounding conductor in each conduit. Bond at boxes and equipment to which conduit is connected.
 - 3) Conduit Under Slab, Above Finished Ceiling:
 - a) Attach conduit to bottom of slab or structure supporting the slab.
 - b) Firestop through-penetrations of the slab.
 4. If any portions of the conduit system cannot be installed concealed due to conditions encountered in the building, report such conditions and await approval in writing before proceeding.
- D. Conduits Penetrating Concrete Floor Slabs (Concrete slabs that are both ceilings and floors shall be treated as floor slabs):
 1. Provide a minimum of 2 inches between conduits that vertically penetrate elevated concrete slabs.
 2. Provide firestopping and spray on fireproofing at locations where conduits penetrate surface of floor slab and slab is part of fire rating required for construction.
- E. Conduit Installed Exposed:
 1. Install conduit exposed where indicated on the drawings.
 2. Install conduit tight to the surface of the building construction unless otherwise indicated or directed.
 3. Install vertical runs perpendicular to the floor.
 4. Install runs on the ceiling perpendicular or parallel to the walls.
 5. Install horizontal runs parallel to the floor.
 6. Do not run conduits near heating pipes.
 7. Installation of conduit directly on the floor will not be permitted.
- F. Conduit Size: Not smaller than 1/2 inch electrical trade size. Where type FEP, THHN, THWN, THWN-2, XHH, XHHW, or XHHW-2 conductors are specified for use under Section 260519, the minimum allowable conduit size for new Work shall be based on Type THW conductors.
- G. Conduit Bends: For 1/2 and 3/4 inch conduits, bends may be made with manual benders. For all conduit sizes larger than 3/4 inch, manufactured or field fabricated offsets or bends may be used. Make field fabricated offsets or bends with an approved hydraulic bender.

3.03 RACEWAY SCHEDULE

- A. Rigid Ferrous Metal Conduit: Install in all locations unless otherwise specified or indicated on the drawings.
- B. Intermediate Ferrous Metal Conduit: May be installed in all dry and damp locations except:
 1. Hazardous areas.
 2. Where other type raceways are specified or indicated on the drawings.

- C. Electrical Metallic Tubing:
1. May be installed concealed as branch circuit conduits above suspended ceilings where conduit does not support fixtures or other equipment.
 2. May be installed concealed as branch circuit conduits in hollow areas in dry locations, including:
 - a. Hollow concrete masonry units, except where cores are to be filled.
 - b. Drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.
 3. May be installed exposed as branch circuit conduits in dry non-hazardous locations at elevations over 10'-0" above finished floor where conduit does not support fixtures or other equipment.
- D. Flexible Metal Conduit: Install equipment grounding conductor in the flexible metal conduit and bond at each box or equipment to which conduit is connected:
1. Use for final conduit connection to recessed lighting fixtures in suspended ceilings. Use 4 to 6 feet of flexible metal conduit, minimum size 1/2 inch, between junction box and fixture. Locate junction box at least 1 foot from fixture and accessible if the fixture is removed.
 2. Use 1 to 3 feet of flexible metal conduit for final conduit connection to:
 - a. Emergency lighting units.
 - b. Dry type transformers.
 - c. Motors with open, drip-proof or splash-proof housings.
 - d. Equipment subject to vibration (dry locations).
 - e. Equipment requiring flexible connection for adjustment or alignment (dry locations).
 3. Use for concealed branch circuit conduits above existing non-removable suspended ceilings where rigid type raceways cannot be installed due to inaccessibility of space above ceiling.
 4. May be installed concealed as branch circuit conduits in drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.
- E. Liquid-tight Flexible Metal Conduit: Install equipment grounding conductor in liquid-tight flexible metal conduit and bond at each box or equipment to which conduit is connected:
1. Use 1 to 3 feet of liquid-tight flexible metal conduit (UL listed and marked suitable for the installation's temperature and environmental conditions) for final conduit connection to:
 - a. Motors with weather-protected or totally enclosed housings.
 - b. Equipment subject to vibration (damp and wet locations).
 - c. Equipment requiring flexible connection for adjustment or alignment (damp and wet locations).
- F. Rigid Nonmetallic PVC Conduit:
1. Schedule 40:
 - a. Use for protection of primary feeders within transformer vaults.

- G. Surface Metal Raceway: Use as exposed raceway system in finished spaces at locations indicated on the drawings.
1. Use surface metal raceway system of size required for number of wires to be installed therein. Use specific size when indicated on the drawings.
 2. Do not run raceway through walls that have a plaster finish nor through masonry walls or floors. Install a pipe sleeve, or a short length of conduit with junction boxes or adapter fittings for raceway runs through such areas. Run raceway along top of baseboards, care being taken to avoid telephone and other signal wiring. Where raceway crosses chair railing or picture molding, cut the chair railing or picture molding to permit the raceway to lie flat against the wall. Run raceway around door frames and other openings. Run raceway on ceiling or walls perpendicular to or parallel with walls and floors.
 3. Secure one piece raceway every 30 inches alternately with 2 hole straps, and support clips (2 hole strap, support clip, 2 hole strap, etc.). Secure 2 piece raceway every 30 inches alternately with 2 hole straps and fasteners through back of raceway (2 hole strap, fastener through back, 2 hole strap, etc.).
 4. Secure raceway at intervals not exceeding 36 inches.
 5. Install separate equipment grounding conductor for grounding of equipment. The raceway alone will not be considered suitable for use as an effective path to ground.
 6. Outlet box covers for pendant mounted fluorescent fixtures may be omitted if the fixture canopy is notched to receive the raceway and the canopy fits snugly against the ceiling.
 7. Where equipment is mounted on an outlet box and the equipment base is larger than the outlet box, provide finishing collar around equipment base and outlet box or provide finishing collar/outlet box:
 - a. Finishing Collar: Same finish and peripheral dimensions as the equipment base, including provisions for mounting, slots to fit over raceway and of depth to cover outlet box and extend back to ceiling or wall.
 - b. Combination Finishing Collar/Outlet Box: Same finish and peripheral dimensions as the equipment base to be mounted thereon, gage or thickness of metal as required by NFPA 70, including provision for mounting and knockouts for entrance of raceway.
- H. Multioutlet Assembly: Use at locations indicated on drawings.
1. Do not run multioutlet assembly through walls or floors. Install a pipe sleeve, or a short length of conduit with junction boxes or adapter fittings for runs through such areas.
 2. Secure multioutlet assembly every 30 inches alternately with 2 hole straps and fasteners through back of multioutlet assembly (2 hole strap, fastener through back, 2 hole strap, etc.).
 3. Secure multioutlet assembly at intervals not exceeding 36 inches.
 4. Install separate equipment grounding conductor for grounding of equipment. The multioutlet assembly alone will not be considered suitable for use as an effective path to ground.

- I. Wireways: May be used indoors in dry locations for exposed raceway between grouped, wall mounted equipment.
- J. Plastic Coated Rigid Metal Conduit: Use at locations indicated on drawings.
- K. Chrome Plated or Stainless Steel Conduit: Use in operating, autopsy and x-ray rooms where conduit is required to be installed exposed. Install conduit and fittings with special tools to avoid damaging finish. Install Work in accordance with NFPA 70 Chapter 5, Hazardous Location Articles 500 thru 508 and Article 517 (Health Care Facilities).

3.04 FITTINGS AND ACCESSORIES SCHEDULE

- A. General:
 - 1. Use fittings and accessories that have a temperature rating equal to, or higher than the temperature rating of the conductors to be installed within the raceway.
 - 2. Use zinc electroplate or hot dipped galvanized steel/malleable iron or cast iron alloy fittings and accessories in conjunction with ferrous raceways in dry and damp locations unless otherwise specified or indicated on the drawings.
 - 3. Use insulated grounding bushings or grounding wedges on ends of conduit for terminating and bonding equipment grounding conductors, when required, if cabinet or boxes are not equipped with grounding/bonding screws or lugs.
 - 4. Use caps or plugs to seal ends of conduits until wiring is installed to exclude foreign material.
 - 5. Use insulated grounding bushings on the ends of conduits that are not directly connected to the enclosure, such as stub-ups under equipment, etc., and bond between bushings and enclosure with equipment grounding conductor.
 - 6. Use expansion fittings where raceways cross expansion joints (exposed, concealed, buried).
 - 7. Use deflection fittings where raceways cross expansion joints that move in more than one plane.
 - 8. Use 2 locknuts and an insulated bushing on end of each conduit entering sheet metal cabinet or box in dry or damp locations.
 - a. Plastic bushing may be used on 1/2 and 3/4 inch conduit in lieu of insulated bushing.
 - b. Terminate conduit ends within cabinet/box at the same level.
- B. For Rigid and Intermediate Metal Conduit: Use threaded fittings and accessories. Use 3 piece conduit coupling where neither piece of conduit can be rotated.
- C. For Electrical Metallic Tubing: Use compression type connectors and couplings.
- D. For Flexible Metal Conduit: Use flexible metal conduit connectors.
- E. For Liquid-tight Flexible Metal Conduit: Use liquid-tight connectors.

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- F. For Rigid Nonmetallic PVC Conduit: Use conduit manufacturer's standard fittings and accessories.
- G. For Surface Metal Raceway: Use raceway manufacturer's standard fittings and accessories.
- H. For Multioutlet Assembly: Use manufacturer's standard fittings and accessories.
- I. For Wireways: Use wireway manufacturer's standard fittings and accessories.

END OF SECTION

SECTION 260553

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide labor, materials, equipment and services, and perform operations required for installation of electrical identification and related work as indicated on the drawings and specified herein.
- B. Work Included: The work shall include, but not be limited to, the following:
 - 1. Electrical power, control and communication conductors.
 - 2. Operational instructions and warnings.
 - 3. Danger signs.
 - 4. Equipment/system identification signs and painting.
- C. Related Work Specified Elsewhere
 - 1. Basic Electrical Requirements
 - 2. Basic Electrical Materials and Methods

1.02 QUALITY ASSURANCE

- A. Materials and equipment shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction.
 - 1. Code Compliance: Comply with applicable electrical code requirements to installation of identifying labels and markers for wiring and equipment.
 - 2. UL Compliance: Comply with applicable requirements of UL Std 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):
 - 1. Brady, W.H. Co.
 - 2. Cole-Flex Corp.
 - 3. Direct Safety Co.

4. Ideal Industries, Inc.
5. LEM Products, Inc.
6. Markal Company
7. National Band and Tag Co.
8. Panduit Corp.
9. Seton Nameplate Co.

2.02 MATERIALS

- A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, provide single selection for each application.
- B. Cable Conductor Identification Bands: Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either prenumbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.
- C. Baked Enamel Danger Signs: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20-gauge steel; of standard red, black and white graphics; 14 inches (350 mm) by 10 inches (250 mm) size except where 10 inches (250 mm) by 7 inches (175 mm) is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.
- D. Engraved Plastic-Laminate Signs: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 1. Thickness: 1/16 inch (1.6 mm), except as otherwise indicated.
 2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.
- E. Lettering and Graphics: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions at the job site where work of this Section is to be performed to insure proper Identification of Electrical Systems
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arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.02 PREPARATION

- A. Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.
- B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.

3.03 APPLICATION AND INSTALLATION

- A. General Installation Requirements
 - 1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of the applicable electrical code.
 - 2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
 - 3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.
- B. Equipment/System Identification
 - 1. Install engraved plastic-laminate signs on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/control/signal system, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2 inch (13 mm) high lettering on 1-1/2 inches (38 mm) high sign (2 inches (50 mm) high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
 - a. Panelboards, electrical cabinets and enclosures.
 - b. Access panel/doors to electrical facilities.
 - c. Major electrical switchboard.
 - d. Power transfer equipment.
 - 2. Install signs at locations indicated or specified. Where not otherwise indicated, at location for convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.
 - 3. Provide a nameplate with 1/4 inch (6.4 mm) white letters on black background, mounted on outside of panelboard trims with nomenclature as indicated on drawings.

4. Provide a nameplate with 1/4 inch (6.4 mm) white letters on black background, mounted on the outside of local disconnects, starters, control devices, pushbuttons, selector switches and pilot lights identifying the equipment served and/or their function.
5. Provide a nameplate with 1/4 inch (6.4 mm) white letters on black background, mounted on the outside of emergency "power-off" stations such as break glass stations, etc. reading "EMERGENCY SHUTDOWN" with identification of equipment being shut down.
6. Provide a typed directory card inserted behind a clear plastic covering within a frame on the inside face of panelboard door identifying circuit utilizations and locations and wire and cable color coding for each voltage system.

END OF SECTION.

SECTION 260950

ELECTRICAL TESTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide labor, materials, temporary wiring, testing equipment, load banks, technical supervision and services, and perform operations required for testing of electrical equipment and installations and related work as specified herein and as shown on the drawings.
- B. Work Included: The work shall include, but not be limited to, the following:
 - 1. Preliminary inspections and tests.
 - 2. Electrical acceptance tests.
 - 3. Operational tests.
- C. Related Work Specified Elsewhere
 - 1. Basic Electrical Requirements
 - 2. Basic Electrical Materials and Methods
 - 3. Other Division 16 sections.

1.02 DESCRIPTION

- A. Preliminary testing and visual inspections shall be conducted prior to acceptance and operational tests to avoid delays.
- B. Electrical acceptance tests shall be conducted to assure that electrical materials, and their installations are in accordance with contract documents, regulatory agencies, applicable codes and standards listed herein, and that they may be energized.
- C. Operational tests shall be conducted to assure capability of equipment and systems to perform as specified and designed.

1.03 QUALITY ASSURANCE

- A. Testing and testing equipment shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction.
 - 1. Regulatory Requirements: Comply with provisions of the applicable electrical code and the

Occupational Safety and Health Administration (OSHA).

2. International Electrical Testing Association: Comply with applicable provisions of NETA Standard ATS-latest edition.
 3. National Fire Protection Association: Comply with applicable provisions of NFPA 70B and NFPA 70E.
- B. Personnel engaged in the testing of electrical equipment and systems shall have a minimum of five (5) years of continuous experience in the testing of the equipment and systems to be tested. Submit evidence of such qualifications to the Architect.
- C. Contractor shall furnish testing equipment as required. Testing equipment, meters and instruments shall have been properly calibrated and certified within six (6) months prior to testing and shall be in satisfactory condition to perform its functions.
- D. Contractor shall provide an appropriate and stable source of electrical power to the test locations.
- E. Electrical equipment and installation shall meet acceptance and operational tests. Promptly repair or replace defective work and repeat the tests until the particular system and component parts thereof receive the approval of the Architect. Any damages resulting from tests shall be repaired and/or damaged materials replaced, to the satisfaction of the Architect.
- F. It is essential that certain trades and manufacturer's technical representatives be present during the testing. These representatives shall include:
1. Electrical subcontractor who is thoroughly familiar with the project as to its intent, what equipment has been provided and how it is supposed to operate.
 2. Supplier of equipment particularly where packaged equipment has been provided.
 3. Manufacturer's representative who is thoroughly familiar with the operation of the equipment.
- G. The operation of the electrical installation by the Owners does not constitute an acceptance of the electrical installations. Final acceptance will depend on Contractor's demonstration of compliance with contract documents, completion of adjustments as specified and required, and submission of required documentation and certification of approval by governing authorities.
- H. Continuity tests shall be performed using direct current and audible bells or buzzers. Use of telephones is not acceptable.
- I. Safety devices such as rubber gloves and blankets, glow detectors, hot sticks, helmets, eye shields, protective screens and barriers, danger signs, etc. shall be used to adequately protect and warn personnel in the vicinity of the tests.

1.04 SCHEDULING

- A. Scheduling of tests shall be as approved by the Architect.
- B. Schedule tests so that equipment can be energized immediately after completing the tests and approval of the reports.
- C. Notify the Architect two (2) weeks prior to testing.

1.05 SUBMITTALS

- A. Submit the following in accordance with the requirements specified under "Submittals" in Section 260010.
 - 1. Submit two (2) copies of test reports including actual readings and corrected readings after each test period.
 - 2. Submit four (4) bound copies of final approved test reports at the completion of tests.
 - 3. Test reports shall be signed by the persons performing the tests and the witnesses to the tests and include, but not be limited to, the following data.
 - a. Date of test.
 - b. Description of equipment tested.
 - c. Description of test.
 - d. Test results.
 - e. Conclusions and recommendations.
 - f. Identification of test equipment.
 - 4. Include copies of the final approved test reports in the maintenance manuals.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions at the job site where work of this Section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.02 PREPARATION

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- A. Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.
- B. Cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.
- C. Testing of outdoor equipment shall not be performed during inclement weather. Ground resistance tests on direct buried ground conductors or rods shall not be performed within 48 hours after rainfall.
- D. Megger and high potential testing shall not be performed during periods of high relative humidity. A guard shall be stationed at each location where exposed cables, buswork, connections or other components exist during megger and high potential testing.
- E. Equipment shall be thoroughly cleaned prior to testing. Vacuum the interiors of cubicles and remove foreign material. Insulators, bushings and bus supports shall be wiped clean with a lint free cloth.
- F. Preliminary tests and visual inspections of the electrical installation including verification checks of factory wiring shall be conducted prior to electrical acceptance and operational tests to avoid delays, and to assure that equipment and installations are free of faulty conditions prior to the application of test voltages.
- G. Where the equipment or system under test is interrelated with and depends upon other equipment, systems and/or controls for proper operation, functioning and performance, the latter shall be operated simultaneously with the equipment or system under test.
- H. Test fuses for continuity.
- I. Test current transformers for continuity and proper polarity.
- J. Test potential transformers for continuity and absence of short circuits.
- K. Set protective devices in accordance with the approved coordination study.
- L. If generators, motors or transformers require drying out to obtain the required insulation values, the drying method shall be in accordance with the manufacturer's recommendations.
- M. Verify that shipping devices and restraints have been removed.
- N. Check for proper interconnection and tightness at connections of shipping sections.

3.03 APPLICATION

- A. Full load currents of feeders serving single phase loads shall be measured to assure an equal load balance on each phase. Branch circuits shall be reconnected if necessary to achieve this balance.
- B. Megger values specified are minimum acceptable values at an ambient temperature of 60 degrees F and low relative humidity. Contractor shall convert readings to equivalent values at 60 degrees F if

measurements are taken under other conditions.

- C. The phase rotation at busses, panels, switchboards, etc. shall be checked and verified using a phase sequence meter for consistency and conformity to recognized standards, i.e. A-B-C left to right, top to bottom, front to back, when facing front of the equipment, and to provide an A-B-C (1-2-3) clockwise rotation. Where electrical installations and extensions of existing systems, or in new buildings at existing sites, phase rotation shall conform to the existing.

3.04 TESTS

A. Low Voltage Wire and Cable (600 Volts and Less)

1. Wire and cable shall be tested for continuity, freedom from short circuits and grounds and meggered to assure adequate insulation resistances for each conductor.
2. Test Voltages: Megger instrument shall be 1000 volts DC applied for one minute.
3. Acceptable Test Results: Insulation resistance between phase conductors and any phase conductor to ground shall be not less than 2 megohms for connected conductors and 100 megohms for disconnected conductors.

B. Panelboards

1. Equipment shall be tested for continuity, freedom from short circuits, and grounds and meggered to assure adequate resistances.
2. Test Voltages: Megger instrument shall be 1,000 volts DC for equipment rated 480 volts and 500 volts DC for equipment rated 250 volts, applied for one minute.
3. Acceptable Test Results: Insulation resistance phase to phase and any phase to ground shall be not less than 100 megohms for equipment rated 480 volts and 25 megohms for equipment rated 208 volts.

C. Switchboards

1. Test electrical and mechanical interlock systems for proper operation and sequencing.
2. Test ground connections as specified under "Grounding System."
3. Perform ratio and polarity tests on instrument current and potential transformers.
4. Perform insulation resistance tests on each bus section, phase to phase and phase to ground as specified under "Panelboards." Prior to performing insulation resistance tests on buswork, isolate the buswork by racking out or opening circuit breakers and disconnects, short circuit and ground current transformer secondaries, remove potential transformer primary fuses and assure grounding of the enclosure.
5. Perform control wiring performance tests using the approved manufacturer's elementary diagrams.

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6. For selective switchboard arrangements, verify proper phasing between the line and load stabs of the tie breaker cubicle busses using hot-phase hot-stick techniques, A-A, B-B, C-C.
7. Test disconnect switches as specified under "Circuit and Motor Disconnects."
8. Perform an insulation resistance test at 1000 volts DC on each circuit breaker for one (1) minute from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase. Insulation resistance shall not be less than 100 megohms.
9. Control and instrument switch test shall include the following:
 - a. Inspect contacts and shunts, cleaning contacts if required.
 - b. Operate switch and note that design functions are performed in proper sequence.
10. Ammeters shall be tested as follows:
 - a. Check connections from current transformers for AC shunts for DC to ammeters.
 - b. Check ammeter scale with current transformer ratio for AC and shunt millivolt rating for DC.
 - c. Set pointer on zero scale with no load.
11. Power factor and VAR meter tests shall include checking polarities of instrument transformers and connecting so lagging current will be to right of center.
12. Voltmeter tests shall include the following:
 - a. Check voltmeter scale with potential transformer ratio.
 - b. Set pointer on zero scale with no voltage.
 - c. Check voltmeter reading with test voltmeter when energized.
13. Wattmeter and watthour meter tests shall include the following:
 - a. Check with current transformer and potential transformers ratio.
 - b. Set wattmeter pointer on zero scale with no load.
 - c. Check rotation on watthour meter.
14. Tests of instrument transformers shall include the following:
 - a. Physically check polarity mark orientation on CTs and PTs with three line diagram on the plans and with manufacturer's drawings.

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b. Check CT and PT polarity markings.

15. Electrical controls shall be tested by trial operation of control equipment after wiring is completed to see that each interlock and control function operates according to the manufacturer's operating instructions.

D. Motors

1. Motors shall be tested for freedom from short circuits and grounds meggered to assure adequate resistances.
2. Test Voltages: Megger instrument shall be 2,500 volts DC for testing 4,000 volt motors, 1,000 volts DC for testing 460 volt motors and 500 volts DC for testing 200 volt motors, applied for one minute.
3. Acceptable Test Results: Insulation resistance phase to ground shall be not less than 100 megohms for 4,000 volt motors, 20 megohms for 460 and 200 volt 3-phase motors and 5 megohms for 115 volt single phase motors.
4. Apply voltage momentarily and check each motors for correct direction of rotation. Correct if necessary.
5. Measure full load current readings of each motor and verify that the correct size heater elements have been provided for each starter overload relay. Where current flow exceeds the motor's nameplate value, install a "DO NOT OPERATE" tag, advise the Architect and notify the Contractor to immediately correct the condition. If power factor correction capacitors are connected on the load side of the overload heaters, include the capacitive reactances in determining the proper overload heater size.
6. Submit a tabulation of each motor indicating the equipment identification, motor horsepower, voltage, measured full load current and heater rating and manufacturer's catalog number.

E. Grounding System

1. General

- a. Tests on individual ground rods shall be performed with each rod isolated from each other and the grounding system.
- b. Tests on the grounding system shall be made after installation and interconnection of the ground system elements including individual ground rods, ground grid cables, connections to structural steel, reinforcing bars, incoming water piping, ground busses on walls and within equipment, etc.

2. Tests of Individual Ground Rods

- a. Measure the resistance to earth of each individual ground rod using a Biddle Co. ground tester or two auxiliary ground rods as described in IEEE Standard 550 paragraph 3.4.2 using an alternating test current. Locate the auxiliary rods at sufficient

distance from the rod under tests to insure that the regions in which their resistances are localized do not overlap. Calculated resistances to earth shall not exceed 25 ohms.

- b. If the resistance is greater than 25 ohms, it shall be reduced by lengthening the rod or driving additional rods with a minimum separation of 10 feet (3050 mm) and cadwelding the rods together until the resistance is less than 25 ohms.
 - 3. Tests of the Grounding System: Test ground system for continuity by applying a low voltage DC source of current, capable of furnishing up to 100 amperes. The ground path using structural steel must conduct 100 amperes. Resistance as calculated from the current and voltage shall not exceed 5 ohms.
- F. Automatic Transfer Switches: Test transfer switches, by means of simulated power outage; automatic startup by remote-automatic starting, transfer of load, and automatic shutdown. Prior to these tests, adjust transfer switch timers for proper system coordination.
- G. Transformers
 - 1. General
 - a. Transformers shall be tested for continuity, freedom from short circuits and grounds and meggered to assure adequate insulation resistance.
 - b. Isolate transformers by opening the line and load side disconnect and/or disconnect conductors. Tie conductors together on each winding.
 - 2. Test Voltage: Megger instrument shall be 1,000 volts DC for 480 volts windings and 500 volts DC for 208 volt windings. Application of test voltages on 480 volt and 208 volt windings shall be held until the readings become constant and until three consecutive equal readings one minute apart are achieved.
 - 3. Acceptable Test Results: Insulation resistance from winding to winding and winding to ground shall be not less than the following, corrected to 20 degrees C.

Minimum Insulation
Resistance in Megohms

Transformer Coil Rating	Dry Type
0 - 600 volts	500

- H. Circuit and Motor Disconnects: Upon completion of the installation of electrical disconnects, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation and for verification of type and rating of fuses installed. Correct deficiencies, then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

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- I. Shunt Trip Operation: Test the emergency-off circuits to assure proper operation of shunt trip circuit breakers.
- J. Receptacles
 - 1. Upon completion of wire tests, check receptacles for proper voltages and phasing, utilizing a receptacle tester for 120 volt 15 and 20 ampere devices and a voltmeter for other devices.
 - 2. Test three phase receptacles for proper phase rotation using a phase sequence meter.
 - 3. Grounded receptacles shall be tested for location and the effectiveness of the ground insert.
 - 4. Test ground fault circuit interrupter receptacles with both local and remote fault simulations in accordance with the manufacturer's recommendations.
- K. Lighting Switches and Occupancy Sensors: Test lighting switches and occupancy sensors for correct operation with special emphasis on 3-way switches.
- L. Lighting Fixtures: Verify proper operation of lighting fixtures.
- M. Control Circuits: Test control circuits for proper functioning and fail safe operation.
- N. Fire Alarm System
 - 1. Provide the services of a factory-authorized service representative to supervise the field system pretesting, testing, adjustment and programming.
 - 2. Pretesting: Upon completing installation of the system, align and adjust the system and perform pretesting. Determine, through pretesting, the conformance of the system to the requirements of the drawings and specifications. Correct deficiencies by replacing malfunctioning or damaged items with new items and retest until satisfactory performance and conditions are achieved.
 - 3. Testing
 - a. Perform electrical and mechanical tests required by the equipment manufacturer's certification form. In addition, measure and adjust each of the ionization detectors to the maximum stable sensitivity setting. This shall be performed with the detector at its operational location and under normal operational environmental conditions in the area. Bench settings are not acceptable.
 - b. The completed smoke detection system shall be tested to insure that it is operating properly. This test shall be witness tested by the Fire Marshal. This test shall consist of exposing the installed units to a standard fire test. In the event the system does not operate properly, the test shall be terminated. Corrections shall be made and the testing procedures shall be repeated until it is acceptable to the Fire Marshal. Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a ninety (90) day test period without any unwarranted alarms. Should an unwarranted alarm(s) occur, the

Contractor shall readjust or replace the detector(s) and begin another ninety (90) day test period. The Contractor shall recheck the detectors using the fire test after each readjustment or replacement of detectors. This test shall not start until the Owner has obtained beneficial use of the building under tests.

- c. Wiring shall be checked and tested to insure there are no grounds, opens or short circuits.
- d. A checkout report shall be prepared and submitted, one copy of which shall be registered with the equipment manufacturer. The report shall include, but not be limited to:
 - 1) A list of equipment installed and wired.
 - 2) Indication that equipment is properly installed and functions and conforms with these specifications.
 - 3) Test of individual zones as applicable.
 - 4) Serial numbers, locations by zone and model number for each installed detector.
 - 5) Voltage (sensitivity) settings for each ionization and photoelectric detector as measured in place with the HVAC system operating.
 - 6) Response time on thermostats and flame detectors.
 - 7) Technician's name, certificate number and date.
- e. After completion of the tests and adjustments listed above, submit the following information to the Architect:
 - 1) "As-built" conduit layout diagrams including wire color code and/or tag number.
 - 2) "As-built" wiring diagrams.
 - 3) Detailed catalog data on installed system components.
 - 4) Copy of the test report.

END OF SECTION

SECTION 262416
PANELBOARDS

PART 1 GENERAL

1.01 SCOPE

- A. Provide panelboards in accordance with the Contract Documents. This section covers the following: 3 phase, 4 wire, 208/120V and 277/480 V distribution panelboards when not integral to unit substation or serving as service entrance.
- B. 3 phase, 4 wire, 120/208V or 277/480 V lighting and appliance Panelboards as required.
- C. UL labeled and rated for service voltage, supplied with protective devices as schedule on drawings, dead-front construction with mains of ampere rating specified on drawings.
- D. Panels to be door in door trim with Yale lock and keyed for #47Key
- E. Related Work Specified Elsewhere
 - 1. 260010 General Electrical
 - 2. Panel Schedules - On Drawings

1.02 SUBMITTALS

- A. Submit shop drawings indicating equipment dimensions, bus bracing, list of component devices and arrangement, finish, trim types and nameplates.

1.03 STANDARDS

- A. NEMA PB 1

PART 2 PRODUCTS

2.01 PANELBOARDS

- A. Acceptable manufacturers are General Electric, Cutler Hammer, Square D. Co., and Siemens
- B. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule.
- C. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage.

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- D. Panelboards shall be minimum 20" wide unless noted otherwise.
- E. The distribution panelboard interior assembly shall be dead front with panelboard front removed. Main lugs or main breakers shall be equipped with safety barriers.
- F. Circuit breakers shall be bolted type:

2.02 **CABINETS AND BOXES**

- A. National Electrical Code gauge steel, completely galvanized or bonderized with gutter size prescribed by Code as minimum.
- B. Finish or flush cabinet exterior and interior shall be manufacturers standard, over rust inhibiting primer.
- C. Surface cabinet exterior to be finished with one coat zinc-chromate and one coat DuPont Precaution Blue enamel.
- D. Provide lug welded or brazed to panelboard box for connection of feeder ground wire (and ground bushing).

2.03 **TRIM AND DOORS**

- A. National Electric Code gauge steel, finished as described in previous paragraphs, shall hinge away on one side exposing all wiring gutters completely and secured by screws on the other side.
- B. Doors are to be flush with concealed hinges with flush catch and lock. Provide two (2) keys per panel #47. Keys for all panels on project to be alike.

2.04 **INTERNAL MOUNTING AND BUSSING**

- A. Assembly of branch circuit units and plated buses on rigid back pan arranged to permit removal of any unit without disturbing adjacent units.
- B. Copper bus ONLY.
- C. Provide main and branch connections as indicated in schedule on plans. Capacities of bus cross section based on UL standards with maximum temperature rise of 30C above a 40C ambient.
- D. Provide appropriate bus work with blank plates for circuits marked "space", "future space" or words to that effect; and provide all details required to connect future circuit breakers.

- E. Main buses and back pan are to be arranged so branch circuit breakers of indicated frame size may be added or changed without machining, drilling, tapping, or altering bus connection details.
- F. Circuits on panelboards to be arranged for sequence phasings. Furnish separate main lugs for each conductor and secure to bus bars by stud bolts. Use two bolts for all lugs for conductors #2-0 and larger.
- G. Provide copper ground bus, electrically and mechanically connected to the box (and ground lug) and equipped with separate UL approved type terminals for each branch circuit of 30 amperes and over ampacity.
- H. Ampacity of neutral bus shall be 100% the size of phase bus.

2.05 **MOLDED CASE CIRCUIT BREAKERS**

- A. Circuit breakers shall be bolt-on type, providing "ON", "OFF", and "TRIPPED" positions of the operating handle. When the breaker is TRIPPED, the handle shall assume a position between the "ON" and "OFF" positions. Breakers shall be of the quick-make, quick-break type with inverse time characteristics secured through the use of bi-metallic and a magnetic tripping element. Breakers shall be Underwriters' Laboratories listed.
- B. Two and three pole breakers shall be the common trip type. Handle extensions providing common manual operation will not be acceptable.
- C. Circuit breakers with 225 ampere or larger frame sizes shall have interchangeable trips.
- D. Provide locking tabs on all circuit breakers serving emergency lighting and other emergency or critical equipment. Provide to the Owner 10 spare locking tabs.
- E. Where required circuit breaker frame amps is not listed at the minimum interrupting capacity, a listed circuit breaker with a higher interrupting capacity shall be used.
- F. Where a circuit breaker is serving an air conditioning unit with multiple motors, breaker shall be "HACR" type.

2.06 **NAMEPLATES FOR PANELBOARDS**

- A. Provide laminated phenolic nameplates with 1/4" white letters on black background mounted on outside trim with nomenclature, as indicated on drawings.

- B. Nameplates to show panelboard number and voltage.
- C. Secure nameplates with sheet metal screws. Adhesive-type nameplates not permitted.

2.07 **PANEL DIRECTORIES**

- A. Provide the following information on all panel directories: Panel designation, Essential or Non-essential distribution source, and feeder size on top of directory card. Trip rating of MCB where applicable.
- B. Sample: Lighting Panel LP/1, 208/120V ESSENTIAL, Feeder Switch=100 Amp located on existing H.S. Brd., Feeder Size - (4)- #2, (1)- #6 Grnd. in 1-1/2" cond.
- C. In addition, all panel branch circuits are to be properly identified.

2.08 **SERVICE PANEL SURGE SUPPRESSION**

- A. Service Distribution panel to include Hardwired Secondary Surge Arrester suitable for use in service entrance locations. Surge Arrester must meet requirements of NEC article 280.
- B. Acceptable manufacturers are Square D catalog number SDSA3650.
- D. Install per manufactures recommendations.

PART 3 **EXECUTION**

3.01 **INSTALLATION**

- A. Panelboards shall be installed where indicated, plumb, level and true and shall be rigidly supported independently of conduits with supporting devices as required.
- B. Prior to installing recessed panelboards, verify that the wall is of sufficient depth to completely cover the back box on all sides.
- C. All panelboards shall be grounded in accordance with the NEC.
- D. At all recessed panelboards, provide (1) 1-1/4" empty conduit for future branch circuits in the wall from the panelboard to the ceiling cavity above cap.

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- E. Installation of adjacent panelboards shall be such that top trims are level and at the same height.
- F. Where two (2) section panels are required, bolt boxes together to form one unit. Trim shall be two-piece construction with doors of equal size over each section.
- G. Wiring in panelboards shall be fanned into the circuit breakers in a neat workmanlike manner and neatly secured together with plastic tie wraps.
- H. Cables installed in wiring gutters of panelboards shall be neatly bundled, routed, and supported. Minimum bending radii as recommended by the wire and cable manufacturer shall not be reduced.
- I. Circuit numbers on the drawings are for identification only and do not indicate the position in the panelboard. Connect the circuits with the lightest loads and the receptacle circuits near the top of panel and more heavily loaded circuits near the bottom. Balance all circuits evenly between phases so feeder wires carry approximately equal current. Rebalance is necessary.
- J. In addition to any spare conduits shown, provide 1- 3/4" empty conduit for each 4 spare circuits or fraction thereof from all panels recessed in walls or partitions to the hung ceiling immediately adjacent, or just below. Terminate conduits in bushings in hung ceilings or flush mounted junction boxes 6" high x 12" long at the finished ceiling where hung ceilings do not exist.

END OF SECTION

SECTION 262812
SAFETY SWITCHES

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. The following shall apply to work in this section:
 - 1. Section 260010: “General Provisions for Electrical Work”.

1.02 DESCRIPTION OF THE WORK

- A. Provide Safety Switches as and where shown on the Drawings for service use. Switches shall be fusible type where noted with Service Entrance Label as required.

1.03 SUBMITTALS

- A. Product Data
Catalog sheets, Specifications and Installation Instructions.

1.04 SPARE PARTS

- A. Three spare fuses for each type and size installed.

PART 2 – PRODUCTS

2.01 SAFETY SWITCHES (SINGLE THROW)

- A. NEMA 1 & 3R.
Challenger, Cutler-Hammer, General Electric, Siemens, Square D or Westinghouse Electric, heavy duty type, having:
 - 1. Fused, or unfused as indicated on Drawings and shall be of applicable H. P. rating.
 - 2. Fused switches equipped with fuseholders to accept only the fuses specified in Section 262815.
 - 3. NEMA 1 enclosure unless otherwise indicated on Drawing.
 - 4. Voltage Ratings
 - a. 250V rating for 120V, 208V, or 240V, circuits.
 - b. 600V rating for 277V and 480V circuits.
 - 5. Solid neutral bar when neutral conductor is included with circuit.
 - 6. Ground bar when equipment grounding conductor is included with circuit.

7. Current rating and number of poles as indicated on Drawings.

2.02 NAMEPLATES

A. General

Precision engrave letters and numbers with uniform margins, character size minimum 3/16" high.

1. Phenolic: Two color laminated engravers stock, 1/16" minimum thickness, machine engraved to expose inner core color (white).
2. Aluminum: Standard aluminum alloy plate stock, minimum .032" thick, engraved areas enamel filled or background enameled with natural aluminum engraved characters.
3. Materials for Outdoor Applications: As recommended by nameplate manufacturer to suit environmental conditions.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install switches so that the maximum height above the floor to the center of the operating handle does not exceed 6'-6". When shown as wall mounted switches shall be mounted to horizontal strut supports. Free standing units shall be mounted on a free-standing strut system anchored to the floor, ceiling, and walls.
- B. Identify each safety switch, indicating purpose or load served:
 1. NEMA 1 Enclosures: Rivet or bolt nameplate to the cover.
 2. NEMA 3R Enclosures: Attach nameplate to the cover using adhesive specifically designed for the purpose, or mount nameplate on wall or other conspicuous location adjacent to switch. Do not penetrate enclosure with fasteners.
- C. Provide fusing as indicated on the Drawings.

END OF SECTION

SECTION 262815
OVERCURRENT PROTECTIVE DEVICES,
CIRCUIT BREAKERS AND FUSES

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. The following shall apply to work in this section:
 - 1. Section 260010: “General Provisions for Electrical Work”.

1.02 DESCRIPTION OF WORK

- A. This Section describes the type of circuit breakers and fuses to be provided in safety switches, switchboards, and panelboards.

1.03 SUBMITTALS

- A. Product Data

1.04 SPARES

- A. Provide and deliver the following spare fuses:
 - 1. One set of three for each Service Switch.
 - 2. Three (3) fuses of each type and size for all other fuses.

PART 2 – PRODUCTS

2.01 CIRCUIT BREAKERS

- A. General

Circuit breakers shall be thermal-magnetic type, conforming to the following Specifications:

- 1. Connection to bus shall be by "bolt-on" (or as existing). Plug-in type circuit breakers are not acceptable.
- 2. Breakers shall be equipped with arc chutes or other approved suitable means of quenching arcs.
- 3. Breakers shall have a quick-break operating mechanism on automatic operation.
- 4. Handles of breakers shall be "trip free".
- 5. Handles of breakers shall plainly indicate whether breaker is in "ON", "OFF" or tripped position.

6. Breakers shall be designed to carry 100% of trip rating continuously; to have inverse time delay tripping above 125% of trip rating; and to trip instantaneously at 1000% of trip rating.
7. Multi-pole breakers shall have barriers between poles.
8. Multi-pole breakers shall have a separate tripping element for each pole. Each tripping element shall open all poles. Multi-pole breakers shall have one handle controlling all poles.
9. Breakers of 225-ampere trip rating or less shall have non-tamperable, permanently set trip elements enclosed and sealed in molded composition housing.
10. Single pole breakers shall be rated for not less than 120 volts, A.C.; multi-pole breakers shall be rated for not less than 250 volts A.C.
11. All breakers shall be manufactured in accordance with standards of the National Electrical Manufacturers Association and shall bear Underwriters Laboratories label.
12. Circuit breakers shall have not less than 15-ampere trip ratings for lighting or appliance circuits, unless otherwise indicated on Drawing or required for the circuit protected.
13. Circuit breakers protecting three phase circuits shall be of the three-pole type.
14. Where spaces for future breakers are required, copper connections for mounting of future breakers shall be provided.
15. For single phase 120-volt or 277 volt loads provide Westinghouse Electric Corp, "Quicklag" by General Electric, Challenger Electric, Siemens or Square D. or as existing.
16. For 208 volt or 480 volt circuits to single phase equipment, provide two (2) pole breakers as manufactured by Westinghouse Electric Corp., Challenger, General Electric, Siemens, or Square D Company with time curve 1.
17. For 3-phase, 208 volt or 480 volt circuits to three phase equipment provide three-pole breakers with time curve 1 as manufactured by Westinghouse Electric Corp., General Electric, Challenger Electric, Siemens or Square D.
18. For lighting circuits that are controlled at panel, provide devices rated for switching duty.
19. Circuit breakers shall be mounted in standard panelboards as indicated on the drawings. Frame and sizes of circuit breakers shall conform to the following:

Trip Ratings-Amps	No. of Poles	Frame Size
15-70	1	<u>100 AMP – Frame</u> 240V: Square D, Type QOB-VH (22,000 I.C.) 480/277V: EHB (14,000 I.C.)
15-100	2&3	<u>100 AMP – Frame</u> Same as for 15-70 AMPS trip rating.
101-225	2&3	<u>225 AMP - Frame</u> 240V: Square D, type KA (42,000 I.C.) 480V: Type KA (25,000 I.C.)
226-400	3	<u>400 AMP - Frame</u> 240V: Square D, type LA (42,000 I.C.) 480V: Type LA (30,000 I.C.)

2.02 FUSES

- A. Fuse holders for distribution equipment and panelboards (except as otherwise specified for service switches) shall be equipped with H.R.C. type cartridge fuses of type and voltage required. All fuses including spares shall have a minimum interrupting rating of 200,000 R.M.S. amperes the equal of Bussman or Gould Shawmut.
1. All Circuits 600A and Below:
 - a. Dual element, time delay, current limiting 600 amp maximum rating at required voltage, and 200,000 amp interrupting rating.
 - b. Similar to type low peak LPN-RK (rating)- SP, 250 volt, 15-600A or low peak LPS-RK (rating) - SP, 600 volt, 15-600A (U.L. Class RK1 with dual element time delay).

END OF SECTION